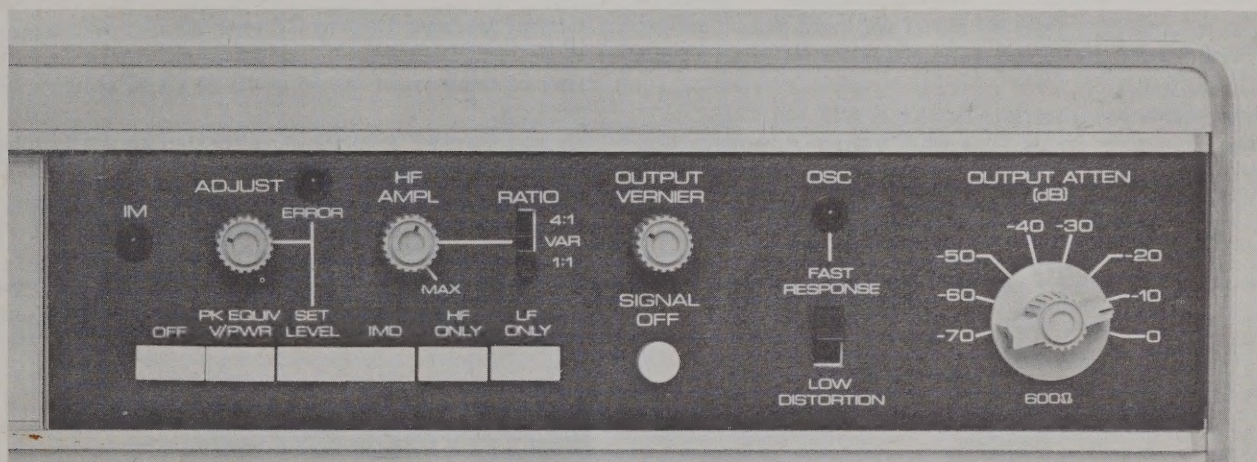


INTERMODULATION DISTORTION ANALYZER



*Measure total harmonic distortion and intermodulation distortion
with one instrument —*

THIS OPTION FITS RIGHT IN THE 1700B DISTORTION MEASUREMENT SYSTEM

- Measures Intermodulation Distortion down to .0025%.
- 70 dB Output Attenuator tracks 1700B Input Switch for rapid measurements, works when measuring THD, too.
- Available with automatic set level to cover between 10 dB steps for even faster operation.
- 4:1 and 1:1 ratios are switch selectable. No HF or LF adjustment required.
- Continuously adjustable LF:HF ratio lets you choose the ratio you want using the 1700B meter.
- Measures peak equivalent single-tone voltage or power.



SOUND TECHNOLOGY

1400 DELL AVENUE
CAMPBELL, CALIFORNIA 95008
(408) 378-6540

Specifications

MEASUREMENT SECTION

All 1700B specifications and performance features are retained with the following additions.

Intermodulation Distortion Ranges: 0.01% to 100% full scale in 9 ranges.

Residual Intermodulation Distortion and Noise: $< 0.0025\%$ with internal generators set at 4:1 for input signals greater than 0.3V (10 mw across 8Ω). $< 0.004\%$ for input signals 0.1V to 0.3V.

Intermodulation Distortion Accuracy: $\pm 2\%$ full scale.

Peak Equivalent Single Tone RMS Voltage Accuracy: $\pm 2\%$ full scale.

GENERATOR SECTION

Output attenuator and vernier control the single tone sine-wave oscillator output as well as the intermodulation distortion generator output. All 1700B oscillator specifications apply except output level control is via the attenuator and output impedance is 600Ω .

Output Voltage: 1mV to 3V open circuit, peak equivalent single tone RMS.

Output Attenuator: 70 dB in 10 dB steps, accurate within ± 0.1 dB.

Output Vernier: > 10 dB range, continuously adjustable.

Output Impedance: $600\Omega \pm 1\%$.

Low Frequency Generator: 50 or 60 Hz synchronized with power line. Total Harmonic Distortion $< 0.1\%$.

High Frequency Generator: 7 kHz $\pm 1\%$.

LF/HF Ratio: Switch selectable 4:1 $\pm 1\%$ or 1:1 $\pm 2\%$. Continuously variable from 1:1 to $> 100:1$ with HF amplitude control.

GENERAL

Weight: Adds 5 lbs. to 1700B weight.

Data subject to change without notice.

MODEL 1700B
INTERMODULATION DISTORTION ANALYZER
OPTION 004

SOUND TECHNOLOGY

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May, 1976

CONTENTS

SECTION		Page
I	GENERAL INFORMATION.	1-1
	1-1. INTRODUCTION.	1-1
	1-2. MEASUREMENT TECHNIQUE	1-1
	1-3. IMD OPTION.	1-1
II	OPERATION.	2-1
	2-1. CONTROLS AND INDICATORS	2-1
	2-2. OPERATING INSTRUCTIONS.	2-1
	2-3. TEST SET-UP.	2-1
	2-4. IM DISTORTION MEASUREMENT WITH 4:1 or 1:1 LF:HF AMPLITUDE RATIO	2-1
	2-5. IM DISTORTION MEASUREMENT WITH NON-STANDARD LF:HF RATIO	2-1
	2-6. IM DISTORTION MEASUREMENT WITH AUTO LEVEL SET	2-2
III	PRINCIPLES OF OPERATION.	3-1
	3-1. INTRODUCTION.	3-1
	3-2. IM SIGNAL SOURCE.	3-1
	3-3. IM ANALYZER	3-1
IV	MAINTENANCE.	4-1
	4-1. INTRODUCTION.	4-1
	4-2. TEST EQUIPMENT.	4-1
	4-3. PERFORMANCE CHECK	4-1
	4-4. INTRODUCTION	4-1
	4-5. INTERMODULATION RESIDUAL DISTORTION TEST	4-1
	4-6. ADJUSTMENT AND CALIBRATION PROCEDURE.	4-2
	4-7. IM GENERATOR	4-2
	4-8. OSCILLATOR ADJUSTMENTS	4-2
	4-9. 4:1 DIVIDER CONFIDENCE CHECK	4-3
	4-10. IM ANALYZER.	4-3
	4-11. PEAK DETECTOR AND THD SIGNAL LEVEL ADJUSTMENTS	4-3
	4-12. ABSOLUTE VALUE DETECTOR OFFSET NULL.	4-3
	4-13. IMD MEASUREMENT CALIBRATION.	4-4
	4-14. AUTO SET LEVEL ADJUSTMENT.	4-5
	4-15. TROUBLESHOOTING	4-5
	4-16. SYMPTOM/CAUSE TABLE	4-5
	4-17. COMPONENT REPLACEMENT-CALIBRATION AND ADJUSTMENT.	4-5
	4-18. ACCESS TO LOW-DISTORTION OSCILLATOR	4-5
V	MODIFICATIONS FOR EUROPE AND JAPAN	5-1
	5-1. DIN (EUROPE).	5-1
	5-2. 50/60 Hz OPERATION (JAPAN).	5-1
VI	DIAGRAMS	6-1
	6-1. COMPONENT LOCATION, IM GENERATOR BOARD.	6-1
	6-2. SCHEMATIC DIAGRAM, IM GENERATOR	6-2
	6-3. COMPONENT LOCATION, IM ANALYZER BOARD	6-3
	6-4. SCHEMATIC DIAGRAM, IM ANALYZER.	6-4
VII	SPARE PARTS.	7-1
	7-1. INTRODUCTION.	7-1
	7-2. ORDERING INFORMATION.	7-1

WARRANTY

All new Sound Technology products are warranted against defects in materials and workmanship for one year from the date of delivery. Any instrument or component that is found to be defective within the warranty period after examination by Sound Technology or an authorized representative thereof will be repaired or replaced without charge for labor or material. No other warranty is expressed or implied. We are not liable for consequential damages.

Before returning a product to Sound Technology for service, authorization must be obtained from the factory. For products not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay. Please include instrument model number and serial number with all requests for parts or service to facilitate the fastest possible response.

All products returned to the factory must be shipped prepaid. For products under warranty, Sound Technology will pay for shipment back to the customer.

1-1. INTRODUCTION

This supplement provides operating and service information for the Model 1700B Intermodulation Distortion (IMD) Analyzer Option 004. The information contained in the supplement pertains to the IMD option only. Consult the Model 1700B manual for additional information regarding primary power requirements, grounding details, and cabling instructions.

1-2. MEASUREMENT TECHNIQUE

The IMD option is based on the SMPTE (Society of Motion Picture and Television Engineers) method to measure IMD whereby a large 60-Hz signal is combined with a small 7 kHz signal in a four-to-one amplitude ratio. Passing this combined (composite) signal through a non-linear device results in the appearance of new frequencies above and below 7 kHz in multiples of 60 Hz. The effect of these new frequencies is amplitude modulation of the 7 kHz signal, which can be detected.

The component parts of the IMD option include a signal source and an IM analyzer. The signal source generates a low-frequency sinusoid and a high-frequency sinusoid that are mixed and fed to the input of the device under test. Level controls are provided so that the amplitude of the composite signal can be set to the desired level. The signal from the output of the device under test is then fed back to the analyzer circuits of the IMD meter. A high-pass filter removes the low frequency, leaving only the high frequency together with any possible low-frequency modulation. This signal is input to an envelope detector (or absolute value detector) resulting in only the rectified carrier with its amplitude varying at a low-frequency rate. A low-pass filter removes the carrier, leaving only the modulation products. The amount of these products is indicated on the meter in terms of percentage of the high-frequency signal passed through the high-pass filter.

1-3. IMD OPTION

This option adds IMD measurement capability to the Model 1700B Distortion Measurement System. It employs the IMD measurement technique described above and in addition provides the user with a number of unique operating features. These are detailed in the following paragraphs.

The IM signal source contains a 60 Hz low-frequency oscillator and a 7 kHz high-frequency oscillator. Controls on the front panel permit a rapid selection of a composite test signal having fixed low-frequency to high-frequency ratios of 4:1 or 1:1 plus a variable ratio of greater than 16:1 to 1:1. The amplitude of the test signal is controlled by an accurate 10 dB-per-step attenuator with a range of 70 dB and by a 10 dB vernier control. The amplitude of the composite test signal can be measured directly in peak equivalent rms single tone voltage or power. This parameter, specified by the Institute of High Fidelity for IMD measurements, is defined as the voltage or power level of a sine-wave signal having a peak value equal to the peak value of the composite IM test signal. The ability to make this measurement eliminates the need for meter reading conversion or matching oscilloscope waveforms.

The IMD option combines with the Model 1700B input circuits to provide the option with a differential input configuration. In operation, the IM analyzer is capable of measuring IMD at all power levels between one milliwatt and ten kilowatts across eight ohms, with a residual intermodulation distortion of less than .0025 percent (.004 percent at one milliwatt). Meter sensitivity ranges from 100 percent to .01 percent full scale. The analyzer can also measure the LF-to-HF voltage ratio of the IM test signal from (a) input to the device under test or (b) output from the device to the analyzer. When the analyzer is used with a Model 1700B fitted with Auto Set Level (Option 003) it is possible to perform IMD testing within the range of one milliwatt to ten kilowatts without adjusting the SET LEVEL control. This feature facilitates testing volume compressors/expanders and similar non-linear devices. Operation with the Auto Set Level option also permits the user to switch from Total Harmonic Distortion (THD) testing to IMD testing without having to make adjustments to compensate for the frequency response of the device under test.

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2-1. CONTROLS and INDICATORS

The data sheet at the front of this supplement describes the controls and indicators on the front panel of the Model 1700B IMD option. The following provides additional explanatory information.

- a. OFF pushbutton -- Switches system measurement mode from intermodulation distortion (IMD) to total harmonic distortion (THD). System is in THD mode when pushbutton is in.
- b. PK EQUIV V/PWR pushbutton -- Selects measurement mode whereby meter displays amplitude of IM test signal in peak equivalent rms single tone voltage or power.
- c. OUTPUT ATTEN control -- Varies level of IM test signal in 10 dB steps.
- d. OUTPUT VERNIER control -- Varies level of IM test signal over a 10 dB range.

NOTE

When the IMD option is installed in the 1700B, the output signal is routed through the output attenuator and output vernier at all times, regardless of whether the instrument is in the IMD or THD mode of operation.

- e. RATIO slide switch -- Selects desired low-frequency to high-frequency amplitude ratio of composite IM test signal. Two fixed ratios (4:1 and 1:1) are available. The VAR (variable) position allows selection of a ratio variable from greater than 16:1 to 1:1 with adjacent HF AMPL control.
- f. HF AMPL control -- Adjusts LF:HF ratio of composite IM test signal when RATIO slide switch is set to VAR position. MAX setting (fully clockwise) selects a 1:1 ratio.
- g. HF ONLY pushbutton -- Turns off low-frequency oscillator. When pushbutton is in, only the high-frequency signal is present at SIGNAL OUTPUT connector.
- h. LF ONLY pushbutton -- Turn off high-frequency oscillator. When pushbutton is in, only the low-frequency signal is present at the output.
- i. SET LEVEL pushbutton -- Selects set level function whereby meter displays amplitude of reference high-frequency signal required for IMD measurement.
- j. ADJUST control -- Adjusts amplitude of reference signal for IMD measurement.
- k. ERROR indicator -- Lights during Auto Set Level (Option 003) operation when adjacent ADJUST control is incorrectly set. Correct setting is achieved by turning ADJUST control until indicator is extinguished. Light will also go out if composite input signal is either below 20% or greater than 150% of full scale.
- l. IMD pushbutton -- Selects intermodulation distortion measurement function.
- m. IM indicator -- Lights when system is in IMD measurement mode i.e., whenever PK EQUIV V/PWR, SET LEVEL, or IMD pushbutton is in and HF ONLY and LF ONLY pushbuttons are out.

2-2. OPERATING INSTRUCTIONS

2-3. TEST SET-UP

Refer to Section I of the Model 1700B manual and connect the equipment as shown in Figure 1-1. Also, read and follow the instructions given in paragraphs 1-6 through 1-9 of the same manual before making any IMD measurements. Sync the test oscilloscope to the line frequency and set sweep speed to 5 msec/div.

2-4. IM DISTORTION MEASUREMENT WITH 4:1 or 1:1 LF:HF AMPLITUDE RATIO.

To measure intermodulation distortion with a 4:1 LF:HF composite signal, proceed as follows:

- a. Set Model 1700B ADJUST control to CAL position or AUTO (for auto set level).
- b. Set IM RATIO switch to 4:1.
- c. Press PK EQUIV V/PWR pushbutton.

- d. Ensure that HF ONLY and LF ONLY pushbuttons are in the out position.
- e. Set Model 1700B INPUT switch to desired range setting. Adjust OUTPUT ATTEN switch and OUTPUT VERNIER control for desired rms peak equivalent single tone voltage/power reading. Ensure that meter indication is in upper two-thirds of scale.
- f. Push IM SET LEVEL pushbutton and turn adjacent ADJUST control until meter reads full scale. Omit this step if using auto set level. (See Section 2-6)
- g. Push IMD pushbutton. Adjust Model 1700B RATIO switch until meter deflection is in upper two-thirds of scale, if possible.
- h. Read distortion in either percent or dB as indicated by meter deflection and RATIO switch range setting. For example, if meter reads .67 and RATIO range is 0.1 PERCENT, distortion reading is .067%.
- i. To switch the 1700 to the THD mode, push the OFF pushbutton on the IM panel.

NOTE

It is normal for the 1700B oscillator to go through a few cycles of stabilization when switching from the IMD mode to the THD mode. This is due to the power supply for the main oscillator being turned off when in the IMD mode.

To make an IM distortion reading with a 1:1 LF:HF signal, set the IM RATIO switch to 1:1 and then carry out steps c through i above. Signal output level will increase about 55% when switching from 4:1 to 1:1.

2-5. IM DISTORTION MEASUREMENT WITH NON-STANDARD LF:HF RATIO

To perform an IM distortion measurement using a LF:HF amplitude ratio other than 4:1 or 1:1, proceed as follows:

- a. Set Model 1700B ADJUST control to CAL position or AUTO (for auto set level).
- b. Set IMD option controls as follows:
 PK EQUIV V/PWR pushbutton -----IN
 IM RATIO switch -----VAR
 LF ONLY pushbutton -----IN
 HF ONLY pushbutton -----OUT
 ANALYZER SELECT -----INPUT or GENERATOR
OUTPUT AS DESIRED
- c. Adjust Model 1700B INPUT switch, and OUTPUT ATTEN and OUTPUT VERNIER controls for a full-scale reading on an appropriate meter voltage scale.
- d. Calculate inverse of desired LF:HF ratio. For example if desired ratios is 16:1, inverse would be 1:0.0625, LF:HF.
- e. Set LF ONLY button to out position and press HF ONLY pushbutton. Now adjust HF AMPL control until meter indicates relative high-frequency level determined in step d. For example, for a 16:1 ratio, the HF AMPL control should be adjusted to obtain a meter reading of .0625 of full scale. The INPUT switch can be stepped down to obtain a more accurate reading of the high-frequency signal. For the 16:1 ratio, the INPUT switch can be stepped down two positions, adjusting the meter reading to .625 on the 0-1.0 meter scale.
- f. Now set HF ONLY pushbutton to out position and follow steps c through i of paragraph 2-4.

2-6. IM DISTORTION MEASUREMENTS WITH AUTO SET LEVEL SET

To make an IM distortion measurement using a Model 1700B fitted with the Auto Set Level option proceed as follows:

- a. Turn Model 1700B ADJUST control fully counter-clockwise past CAL position until detent position is reached. This activates the Auto Set Level circuit. The gain of the intermodulation analyzer must be within a certain range for the Auto Set Level to function correctly. The ERROR indicator lights whenever the intermodulation analyzer gain is not within the necessary gain "window". In this event, turn the IM ADJUST control until the ERROR indicator is extinguished. For a further explanation of this see section 3-3.
- b. Follow steps described in paragraphs 2-4 and 2-5.
- c. Observe ERROR indicator; rotate IM ADJUST control until an off "window" is found; then set the IM ADJUST control to the window's approximate center.
- d. To switch the 1700B to the THD mode, push the OFF pushbutton on the IM panel. (It is normal for the 1700B oscillator to go through a few cycles of stabilization when switching from the IMD mode to the THD mode.)

SECTION III PRINCIPLES OF OPERATION

3-1. INTRODUCTION

This section contains a functional description of the IM signal source and the IM analyzer - the principle components of the IMD option. For a description of the IMD measurement technique employed by the option and a description of its operating features, refer to Section I of this supplement.

3-2. IM SIGNAL SOURCE

Refer to the schematic diagram in Section VI of this manual. The IM signal source consists of two Wien bridge RC oscillators, a summing amplifier, and an output attenuator. The low-frequency (LF) oscillator operates at 60 Hz and is synced to the line frequency. The oscillator has an output amplitude of 6.3 volts rms (nominal). The high-frequency (HF) oscillator operates at 7 kHz and also has an output of 6.3 volts rms (nominal). The HF oscillator is optimized for maximum amplitude stability. The signals from both oscillators are coupled to the input of a summing amplifier that supplies the composite IM test signal.

The amplitude ratio of the two frequencies is controlled by varying the amplitude of the HF signal input to the summing amplifier. When the front-panel RATIO slide switch is set to the 1:1 position, the full 6.3 volts rms (nominal) HF signal is delivered to the summing amplifier. When the RATIO slide switch is set to the 4:1 position, a resistive divider attenuates the HF signal by a factor of four, so that the HF level at the summing amplifier output is one-quarter that of the LF level. When the RATIO switch is set to VAR position, a potentiometer controlled by the front-panel HF AMPL knob permits the level of the HF input to the summing amplifier to be set to any level between zero and 6.3 volts rms.

The IM signal source is operable only when the IMD switch is set to the IM (out) position. This disconnects dc operating voltage from THD low-distortion oscillator and allows the 60-Hz and 7 kHz oscillators to turn on. When the IMD OFF switch is pressed, dc power is connected to the THD low-distortion oscillator and at the same time dc voltages are applied to the two IM oscillator circuits biasing them to an off state.

The output attenuator consists of a ladder-type step attenuator in series with a 10-dB "L" attenuator. The ladder section has attenuation steps of 0, 20, 40 and 60dB, changing at every second setting of the front-panel OUTPUT ATTEN switch. Thus, the attenuation of the ladder section is 0 dB for the 0-dB and 10-dB switch settings, 20 dB for the 20-dB and 30-dB settings etc. The 10-dB "L" section is bypassed on the 0-, 20-, 40-, and 60-dB switch settings and connected in series with the ladder section on the 10-, 30-, 50-, and 70-dB settings. This provides the output attenuator with a range of 0 dB to 70 dB in 10-dB steps. The attenuator has a constant output impedance of 600 ohms.

3-3. IM ANALYZER

The following is a discussion of the IM analyzer board and Model 1700B circuits that comprise the IM analyzer. Refer to the schematic diagrams in the Model 1700B manual and Section VI of this manual for circuit details.

The IM test signal from the device under test is connected via the Model 1700B INPUT terminals to the INPUT attenuator and from there to the differential input buffer and differential-to-single-ended buffer. The output signal from the buffer amplifier (in the range of 1 to 3.16 peak equivalent volts), is coupled via a passive 2-pole high-pass filter to the input buffer. The filter attenuates the 60Hz component of the IM signal by approximately 26 dB. The gain of the input buffer is variable from 2 to 100 by the front panel IM ADJUST control. This allows the amplitude of the signal at the output of the IM buffer (TP1) to be set to approximately 3.16 volts, the correct set level for the IM distortion measurement.

From the IM input buffer, the signal is connected to an active 7-pole, high-pass filter having a cut-off frequency of 2kHz. This attenuates the 60 Hz by a further 210 dB, leaving only a pure 7 kHz sine wave plus any amplitude modulation caused by the non-linearity of the device under test. From here, the signal is connected to an absolute value detector that rectifies the 7 kHz waveform.

When the IM SET LEVEL pushbutton is pressed the output of the absolute value detector, which is essentially a dc level representing the amplitude of the 7 kHz component of the test waveform, is connected through switch S3 to the front panel meter. This permits monitoring the amplitude of the HF component of the input signal for Set-Level adjustments.

The output of the absolute value detector is also coupled to a 7-pole, low-pass filter with a cut-off frequency of 500 Hz. This removes the 7 kHz component from the rectified signal, leaving only the intermodulation products. The output from the low-pass filter is connected to the THD RATIO attenuator and distortion amplifier through OFF switch, S1. The amplifier output is 31.6 mV full scale for each attenuator setting.

An IM measurement is made by pressing the IMD pushbutton, connecting the distortion amplifier output via the auto set level option and the IM meter amplifier to the front panel meter. If the auto set level option is not fitted, the signal is jumpered directly from the distortion amplifier to the IM meter amplifier. Also, when the system is in the IM measurement mode, a relay bypasses the 400 Hz and 80 kHz filters located between the distortion amplifier output and the input of the auto set level circuit. This relay is on the THD analyzer board and activated through a contact on relay K1, located on the IM analyzer board.

When the PK EQUIV V/PWR pushbutton switch S2 is pressed, the output of the THD meter preamplifier is connected via the IM peak detector to the front-panel meter. The THD meter preamplifier has a 31.6 mV full scale output on each range of the INPUT attenuator and the peak detector buffer has a gain of approximately 22. This changes the 31.6 mV full scale signal to approximately one volt peak at the peak detector input and causes one milliampere of current to be supplied to the meter for a full scale reading.

The peak detector, consisting of U9 and associated components, operates as a summing amplifier. The input to the circuit may be considered to be at the junction of capacitor C46 and resistor R36. The detector responds to negative input peaks. Meter current (average one milliampere full-scale) flows back to the summing point through resistor R38. If the peak negative input current through R36 exceeds the feedback current, the output of U9 will go positive and add charge to C55 through emitter-follower Q1. This added charge will then increase the average meter current: As long as the output of U9 swings positive each cycle, Q2 will conduct each cycle, thus holding down the voltage on C54 and preventing Q3 from conducting. If the peak input current does not exceed the feedback current, the output of U9 remains clamped negative by diode CR5 at approximately 0.7 volts. In this event, the voltage on C54 will rise, and Q3 will conduct to quickly reduce the charge on C55. This allows the meter to respond quickly to a decreasing signal level.

The Auto Set Level option provides automatically controlled gain at the output of the distortion amplifier to compensate for a 10 dB range of input signal. For THD measurements, gain is simply controlled by the input signal level, which is the reference for the measurement. For IMD measurements, the reference for the measurement is not the input signal (total composite signal) but rather the level of the high-frequency (7 kHz) component. Yet, the input signal level indicated on the front panel meter (pk equiv v/pwr) during the measurement is proportional to the peak value of the composite signal.

For the Auto Set Level to operate over a 10 dB range of peak equivalent volt/power level, it is necessary that the SET LEVEL control be adjusted such that when in the SET LEVEL mode, the meter reads within approximately plus or minus 2 dB of the meter deflection when in the PK EQUIV V/PWR mode. This places the output of the absolute level detector in the proper range to control the auto set level circuit. Once the SET LEVEL control is properly set, no further adjustment is required unless the low-to-high frequency ratio at the analyzer input is changed. Now, the 7 kHz level (absolute value detector output) tracks the input signal level (peak detector output).

In order to avoid possible readout error due to an incorrectly adjusted SET LEVEL control, a "window" detector is incorporated in the IM analyzer. This circuit consists primarily of operational amplifiers U14 and U15. U14 turns on ADJUST light-emitting diode CR24 if the output of the absolute value detector, as divided down by resistors R68, R70 and R71, exceeds the output of the peak detector by approximately 2.5 dB. The peak

detector output is derived from the voltage developed across resistor R38. Conversely, U15 turns on the ADJUST indicator if the output of the peak detector exceeds the output of the absolute value detector, as divided down and appearing at pin 3 of U15, by approximately 2 dB.

Operational amplifiers U16 and U17 act in a similar manner to disable the ADJUST indicator (by absorbing the drive current through R79) if the peak equivalent volt power reading is much too low (less than 20 percent of full scale), or too high (greater than 150 percent of full scale). Here the peak detector output is simply compared to dc levels. Q4 is used to turn off the ADJUST indicator when the instrument is not in the auto mode of operation. If the auto set-level option is not installed, R79 is removed.

The reader may be interested to know that in the U17/U18 comparator circuit, diode CR22 is a redundant component. If the output of U17 goes negative, it pulls the output of U16 negative through the pin 8 connections. Therefore CR22 may be used as a spare diode.

SECTION IV MAINTENANCE

4-1. INTRODUCTION

This section provides a performance check, adjustment and calibration procedures, and troubleshooting information for the IMD option.

4-2. TEST EQUIPMENT

Recommended test equipment for performance checking and troubleshooting is listed in Table 4-1. Test instruments other than those described can be used provided their specifications equal or exceed those listed.

Table 4-1. Required Test Equipment

TYPE	REQUIRED SPECIFICATIONS	USE	RECOMMENDED INSTRUMENT
AC-DC DIGITAL VOLTMETER	Range: 1mV to 2V Accuracy: $0.1\% \pm 1$ digit	Calibration	Fluke Model 8000A
Audio Generator	Frequency Range: to 8 kHz	Calibration	Sound Technology Model 1700 B or 1400A
OSCILLOSCOPE	Bandwidth: 500 kHz Deflection Factor: 5 mV/div Number of Channels: 2	Calibration and Troubleshooting	Hewlett-Packard Model 1200A or Philips Model 3232

4-3. PERFORMANCE CHECK

4-4. INTRODUCTION

The performance check for the IMD option consists of an intermodulation residual distortion test. If the performance limits are exceeded in the following paragraph, refer to the troubleshooting hints in paragraph 4-16.

4-5. INTERMODULATION RESIDUAL DISTORTION TEST

- a. Connect equipment in test configuration shown in Figure 1-1 of Model 1700B manual except connect a cable from SIGNAL OUTPUT/GENERATOR OUTPUT connector of Model 1700B directly to its INPUT terminals. Set Model 1700B ADJUST control to CAL position.

- b. Set IMD option controls as follows:

IM RATIO switch -----4:1
 HF ONLY pushbutton -----out
 LF ONLY pushbutton -----out
 OUTPUT ATTEN switch -----0 dB
 OUTPUT VERNIER control -----max CW

- c. Press PK EQUIV V/PWR pushbutton and set INPUT switch to 3 VOLTS range.
- d. Press IMD SET LEVEL pushbutton and rotate adjacent ADJUST control for a full-scale reading on meter.
- e. Press IMD pushbutton and set RATIO switch to -80 dB/.01 PERCENT range. Check that meter reading is .0025% or less.

4-6. ADJUSTMENT AND CALIBRATION PROCEDURE

This procedure should be performed whenever the results of the performance check (Paragraph 4-3) clearly establish the need to do so. After successfully performing in sequence the procedure in Paragraphs 4-7 through 4-15, the IMD option is considered to be calibrated.

NOTE

When performing this procedure ensure that only the equipment and cables specified are connected to the instrument.

4-7. IM GENERATOR

4-8. OSCILLATOR ADJUSTMENTS

- a. Set front panel controls as follows:

PK EQUIV V/PWR pushbutton -----in
 HF ONLY pushbutton -----out
 LF ONLY pushbutton -----in
 RATIO switch -----1:1
 OUTPUT VERNIER -----max CW
 OUTPUT ATTEN switch -----0dB
 FAST RESPONSE/LOW DISTORTION switch -----Fast Response
 THD ADJUST control -----CAL

(Ignore an indicated overload condition) Remove sync from LF oscillator either by removing connection to power transformer (#7 on Generator Board) or by lifting one end of C19. Connect SIGNAL OUTPUT to a scope with horizontal sweep (5 ms/cm) synced to power line. Adjust R4 for a stationary pattern (LF oscillator running at line frequency). It may be necessary to adjust FET bias (R8) to keep oscillator running as R4 is adjusted. Restore LF osc. sync.

- b. Connect a cable between SIGNAL OUTPUT connector and INPUT terminals.

LF ONLY pushbutton -----out

- c. Measure Q6 gate voltage (an easy place to measure is at C11, .033 uf.). Allowable range is 1.0 to 2.0 Vdc. If out of range, adjust R23 for a reading 1.5 Vdc. Isolate gate voltage from voltmeter probe with a 10 K ohm resistor.
- d. Measure Q3 gate voltage (an easy place to measure is at collector of Q2. Don't forget 10 K isolation!). Allowable range is 1.0 to 2.0 Vdc. If out of range, adjust R8 for a reading of 1.5 Vdc.
- e. Press HF ONLY pushbutton. Adjust OUTPUT VERNIER control until front panel meter reads exactly full scale.

- f. Change front panel controls as follows:

HF ONLY pushbutton -----out
LF ONLY pushbutton -----in

- g. Without changing setting of OUTPUT VERNIER control, carefully adjust R13 until front panel meter indicates same full-scale reading obtained in Step C above.
- h. Repeat Step d above. If it was necessary to readjust R8, repeat Step g.

4-9. 4:1 DIVIDER CONFIDENCE CHECK

- a. Change front panel controls as follows:

INPUT switch -----3V
RATIO switch -----4:1

- b. Adjust OUTPUT VERNIER (and/or R44) for a front panel meter reading as close as possible to 2.40 Vac.
- c. Change front panel controls as follows:

HF ONLY pushbutton -----in
LF ONLY pushbutton -----out
INPUT switch -----1 V

- d. Check that front panel meter reads $0.60 \pm .02$ V.

4-10. IM ANALYZER

4-11. PEAK DETECTOR AND THD SIGNAL LEVEL ADJUSTMENTS

- a. Connect DVM in parallel with cable connected between SIGNAL OUTPUT connector and INPUT terminals.

- b. Change front panel controls as follows:

HF ONLY pushbutton -----out
LF ONLY pushbutton -----in

- c. Adjust OUTPUT VERNIER and OUTPUT ATTEN controls (and/or R44) for DVM reading of 0.800 Vac.

- d. Change front panel controls as follows:

HF ONLY pushbutton -----out
LF ONLY pushbutton -----out

- e. Adjust R34 on IM analyzer board for an exact full-scale reading on front panel meter.

- f. Change front panel controls as follows:

INPUT switch -----3V
OUTPUT ATTEN switch -----0 dB
OUTPUT VERNIER -----max CW

- g. Adjust R44 (IM generator board) for a full-scale reading on front panel meter.

4-12. ABSOLUTE VALUE DETECTOR OFFSET NULL

- a. Remove input signal and set INPUT switch to 3V.

- b. Connect DVM between TP4 and ground (negative end of C34).
- c. Set DVM to its most sensitive range.
- d. Adjust R22 for DVM reading of less than $\pm .003\text{Vdc}$.

4-13. IMD MEASUREMENT CALIBRATION

- a. Connect a cable between SIGNAL OUTPUT and the INPUT terminals with the high side of the SIGNAL OUTPUT connected to the + INPUT terminal.
- b. Connect a 47 kilohm resistor to the + INPUT terminal.
- c. Connect an external audio oscillator between the -INPUT terminal and the floating end of the 47 kilohm resistor.
- d. Set front panel controls as follows:

PK EQUIV V/PWR -----in
 RATIO -----1:1
 HF ONLY -----in
 LF ONLY -----out
 OUTPUT ATTEN -----0dB
 INPUT -----1 Volt Range
 RATIO -----40dB(1%)
 THD ADJUST -----CAL

- e. Connect vertical input of oscilloscope to DISTORTION OUTPUT. Set controls as follows:

Vertical Sensitivity -----20 mV/cm
 Sweep -----5 ms/cm
 Sync -----Internal

- f. Set external audio oscillator frequency to approximately 7 kHz.
- g. With output of external oscillator reduced to zero, adjust OUTPUT VERNIER for 1700B meter reading as close to exact full scale as possible.
- h. Change front panel controls as follows:

OUTPUT ATTEN -----70 dB
 LF ONLY -----in
 INPUT -----.01 volt range

Adjust output of external oscillator for a meter reading as close to exact full scale as possible.

- i. Change front panel controls as follows:

LF ONLY -----out
 OUTPUT ATTEN -----0dB
 INPUT -----3 Volt range

Adjust the frequency of the external oscillator for a 10 to 15 ms period of the sinc wave appearing on the scope.

Adjust IM SET LEVEL control for an exact full scale reading on the meter.

- j. Depress IMD pushbutton. Adjust R63 on the IM Analyzer board for an exact full scale reading.

4-14. AUTO SET LEVEL ADJUSTMENT

- a. Turn THD ADJUST control to AUTO position. Adjust R6 on the auto set level board for an exact full-scale (1.00%) reading.
- b. Switch INPUT switch to 10 volt range. Check that reading is $1.00 \pm .02\%$.

4-15. TROUBLESHOOTING

Before attempting to troubleshoot the IMD Option ensure that the fault is with the option and not caused by the test setup or associated equipment. The performance check (Paragraph 4-3) enables this to be determined without having to remove the covers.

If an abnormal condition is observed during the performance check, table 4-2 will suggest remedies. However, before proceeding with detailed troubleshooting, note the troubleshooting hints contained in paragraph 3-29 of the Model 1700B Manual.

4-16. SYMPTOM/CAUSE TABLE

Table 4-2 contains symptoms of IMD option malfunctions and provides diagnostic tests for the location of these faults. Following the repair of a defective component, refer to paragraph 4-1 for instructions regarding any necessary calibration and/or adjustment procedures.

Table 4-2. IMD Symptom-Cause Table

Symptom	Probable Cause	Diagnostic Test
Abnormally high level of residual IM distortion, distortion product is random noise.	7 kHz oscillator amplitude instability, Q6 gate voltage out of adjustment.	Measure dc level at gate of Q6 on IM analyzer board. Reading should be between 1.0 and 2.0 Vdc.
Abnormally high level of residual IM distortion, distortion product is multiple of 60-Hz	(1) Nonlinearity in IM generator summing amplifier U3, IM analyzer buffer U1. (2) Nonlinearity in THD buffers U101, U102, U103.	(1) Replace U3, U1. (2) Replace U101, U102, U103
Amplitude of 60-Hz oscillator is unstable, or oscillator is not synced to line.	Q3 gate voltage out of adjustment.	Measure dc level of gate of Q3 on IM generator board. Reading should be between 1.0 and 2.0 Vdc. Check freq. adjustment per 4-8a.

4-17. COMPONENT REPLACEMENT - CALIBRATION AND ADJUSTMENT

If U1 or U2 in the generator section are replaced, do the oscillator adjustments, section 4-8. In general, changing IC's in the analyzer section do not require re-adjustment. The exception is U6 in the Absolute Value Detector. Changing U6 would require the zero adjustment at TP4, section 4-12.

4-18. ACCESS TO LOW-DISTORTION OSCILLATOR

In order to reach the low-distortion oscillator assembly, it is necessary to move the IM analyzer board mounted above it. To reach the oscillator, proceed as follows:

- a. Remove top cover from instrument.

- b. Locate metal shield on which IM analyzer board is mounted.
- c. Remove four screws attaching this shield to instrument. Do not remove screws securing IM analyzer board to shield.
- d. Carefully move shield back until pushbuttons on board clear rear of front panel.
- e. Move shield until it is located vertically above center of instrument. Insert upper edge of instrument's center divider into slot on edge of IM analyzer shield. This holds board in a position that permits access to oscillator.
- f. Replace IM analyzer board following reverse procedure.

SECTION V MODIFICATIONS FOR EUROPE AND JAPAN

5-1. DIN (EUROPE)

- a. The Low Frequency Oscillator is set at 250 Hz and is not synchronized with the power line. The High Frequency Oscillator is at 8 kHz. The IM measurement then conforms to DIN 45403, Page 4 - "Measurement of non-linear distortion in electroacoustics; intermodulation method", and DIN 45500, Page 6 - "Hi-Fi techniques, requirements for amplifiers".

A scope sync (250 Hz) is available at a BNC connector on the rear panel.

The Passive, High-Pass Filter has been changed to have a cut-off frequency of 3.9 kHz.

The Low-Pass Filter has been changed to have a cut-off frequency of 1.25 kHz.

- b. The following parts have been changed:

Reference Designators	Description	Stock No.	Qty.
<u>IM Analyzer Board</u>			
C1, C2	.02 uf, 1%, 33V, plystr	2025-0004	2
C3, C4	.0068 uf, 2.5%, 63V, plystr	2025-0016	2
C32	.0082 uf, 1%, 33V, plystr	2025-0002	1
C37	.082 uf, 1%, 33V, plystr	2025-0005	1
C36	.0033 uf, 2.5%, 63V, plystr	2025-0014	1
C36A	680 pf, 2.5%, 63V, plystr	2025-0019	1
R46, 47, 48, 49	5.23 K, 1%, 1/8W, MF	1015-1523	4
<u>IM GENERATOR BOARD</u>			
C1, C2	.022 uf, 2.5%, 63V, plystr	2025-0029	2
R18, 20	10K, .25%, 1/8W, MF	1005-2100	2
R17	10K, 1%, 1/8W, MF	1015-2100	1
R16	52.3K, 1%, 1/8W, MF	1015-2523	1
R3, 5	28.7K, 1%, 1/8W, MF	1015-2287	2

- c. Also, the following changes or additions have been made:

1. Replace R4 (5K trim-pot) with a jumper.
2. Remove R2 (15K, 5%, 1/4W) from board.
3. Remove sync cable to IM generator Board (pad 7).
4. Add shielded cable between pad 5 on generator board and BNC scope sync connector on rear panel.

5-2. 50/60 Hz OPERATION (JAPAN)

The Low Frequency Oscillator is set to 60 Hz and is free-running. A scope sync is available at a BNC connector on the rear panel. Sections 5-1-C-2,3,4 above are applicable.

SECTION VII
SPARE PARTS

7-1. INTRODUCTION

This section contains information for ordering replacement parts, and provides the following details:

- a. Sound Technology part number.
- b. Circuit diagram reference designator.
- c. Description of part.
- d. Total quantities used.

7-2. ORDERING INFORMATION

When ordering replacement parts, each part must be identified by a Sound Technology part number. To order a part, include the following information:

- a. Instrument model number.
- b. Instrument serial number.
- c. Description of part.
- d. Function and location of part.

Address your order or inquiry to:

Sound Technology
1400 Dell Avenue
Campbell
California, 95008
(408)378-6540

1700B DISTORTION ANALYZER

OPTION 004

PURCHASED PARTS

PART NO	DESCRIPTION	QTY	PART NO	DESCRIPTION	QTY
0300-0000	DIODE-LED RED	2.0	1015-1953	RES-FXD 9.53K 1% 1/8W	2.0
	CR24, 25			R70, 72	
1005-1787	RES-FXD 7.87K 0.25% 1/8W MF	1.0	1015-2100	RES-FXD 10K 1% 1/8W MF	13.0
	R32			R1-5, 18, 19, 21, 50-53, 74	
1005-2158	RES-FXD 15.8K 0.25% 1/8W MF	1.0	1015-2113	RES-FXD 11.3K 1% 1/8W MF	1.0
	R27			R11	
1400-0010	RES-VAR 5K 10% MOD. LOG. CARBON	1.0	1015-2130	RES-FXD 13.0K 1% 1/8W MF	4.0
	R31			R46-49	
1400-0011	RES-VAR 5K 10% LINEAR CARBON	1.0	1015-2133	RES-FXD 13.3K 1% 1/8W MF	1.0
	R38			R15	
1400-0012	RES-VAR 1K 10% CCW MOD. LOG. CAR	1.0	1015-2158	RES-FXD 15.8K 1% 1/8W MF	1.0
	R7			R67	
3005-0003	SWITCH-SLIDE DP3T MINIATURE	1.0	1015-2261	RES-FXD 26.1K 1% 1/8W MF	1.0
	S7			R71	
7900-0009	MANUAL-IMA OPTION	1.0	1015-2316	RES-FXD 31.6K 1% 1/8W MF	1.0
8000-0000	PUSHBUTTON-WHITE	6.0		R76	
8000-0006	KNOB-ROUND 1/2 OD, 1/8 ID BEIGE	3.0	1015-2365	RES-FXD 36.5K 1% 1/8W	1.0
8000-0011	KNOB-1/2 DIA, 1" SKIRT, BEIGE	1.0		R73	
01700-1029	SHIELD-IM ANALYZER	1.0	1015-2374	RES-FXD 37.4K 1% 1/8W MF	1.0
01700-1030	BRACKET-REAR IM	1.0		R68	
01700-1032	TRIM PLATE-IMA	1.0	1015-2392	RES-FXD 39.2K 1% 1/8W MF	3.0
01700-1033	SWITCH PLATE-IMA	1.0		R13, 31, 32	
01700-30017	ASSY-PC, IM ANALYZER	1.0	1015-2487	RES-FXD 48.7K 1% 1/8W MF	1.0
01700-30018	PC-ASSY IM SIGNAL GENERATOR	1.0		R9	
01700-30021	ATTN SWITCH ASSEMBLY, IM OPT	1.0	1100-0022	RES-FXD 22 5% 1/4W	1.0
				R62	
			1100-0027	RES-FXD 27 5% 1/4W	1.0
				R41	
			1100-0091	RES-FXD 91 5% 1/4W	2.0
				R60, 61	
			1100-0100	RES-FXD 100 5% 1/4W	4.0
				R54, 56, 57, 69	
			1100-0510	RES-FXD 510 5% 1/4W	2.0
				R45, 80	
			1100-1100	RES-FXD 1K 5% 1/4W	5.0
				R40, 42, 58, 78, 79	
			1100-1330	RES-FXD 3.3K 5% 1/4W	1.0
				R39	
			1100-2100	RES-FXD 10K 5% 1/4W	1.0
				R44	
			1100-2330	RES-FXD 33K 5% 1/4W	1.0
				R43	
			1100-2470	RES-FXD 47K 5% 1/4W	1.0
				R37	
			1100-3100	RES-FXD 100K 5% 1/4W	1.0
				R26	
			1100-4100	RES-FXD 1M 5% 1/4W	2.0
				R55, 59	
			1410-0001	RES-VAR 100 TRIMPOT CERMET	1.0
				R63	
			1410-0002	RES-VAR 500 TRIMPOT CERMET	1.0
				R34	
			1410-0004	RES-VAR 5K TRIMPOT CERMET	1.0
				R22	
			2000-0005	CAP-FXD 5PF 10% 500V MICA	1.0
				C43	
			2000-0007	CAP-FXD 7PF 5% 500V MICA	1.0
				C69	
			2000-0010	CAP-FXD 10PF 5% 500V MICA	1.0
				C28	
			2000-0056	CAP-FXD 56PF 5% 500V MICA	2.0
				C7, 51	
			2000-0150	CAP-FXD 150PF 5% 500V MICA	2.0
				C27, 50	
			2000-0470	CAP-FXD 470PF 5% 500V MICA	1.0
				C47	
			2020-0002	CAP-FXD 0.056UF 10% 100V MYLAR	1.0
				C66	
			2025-0002	CAP-FXD 0.0002UF 1% 33V PLYSTR	3.0
				C8-10	
			2025-0003	CAP-FXD 0.01UF 1% 33V PLYSTR	5.0
				C13, 14, 17, 18, 36	

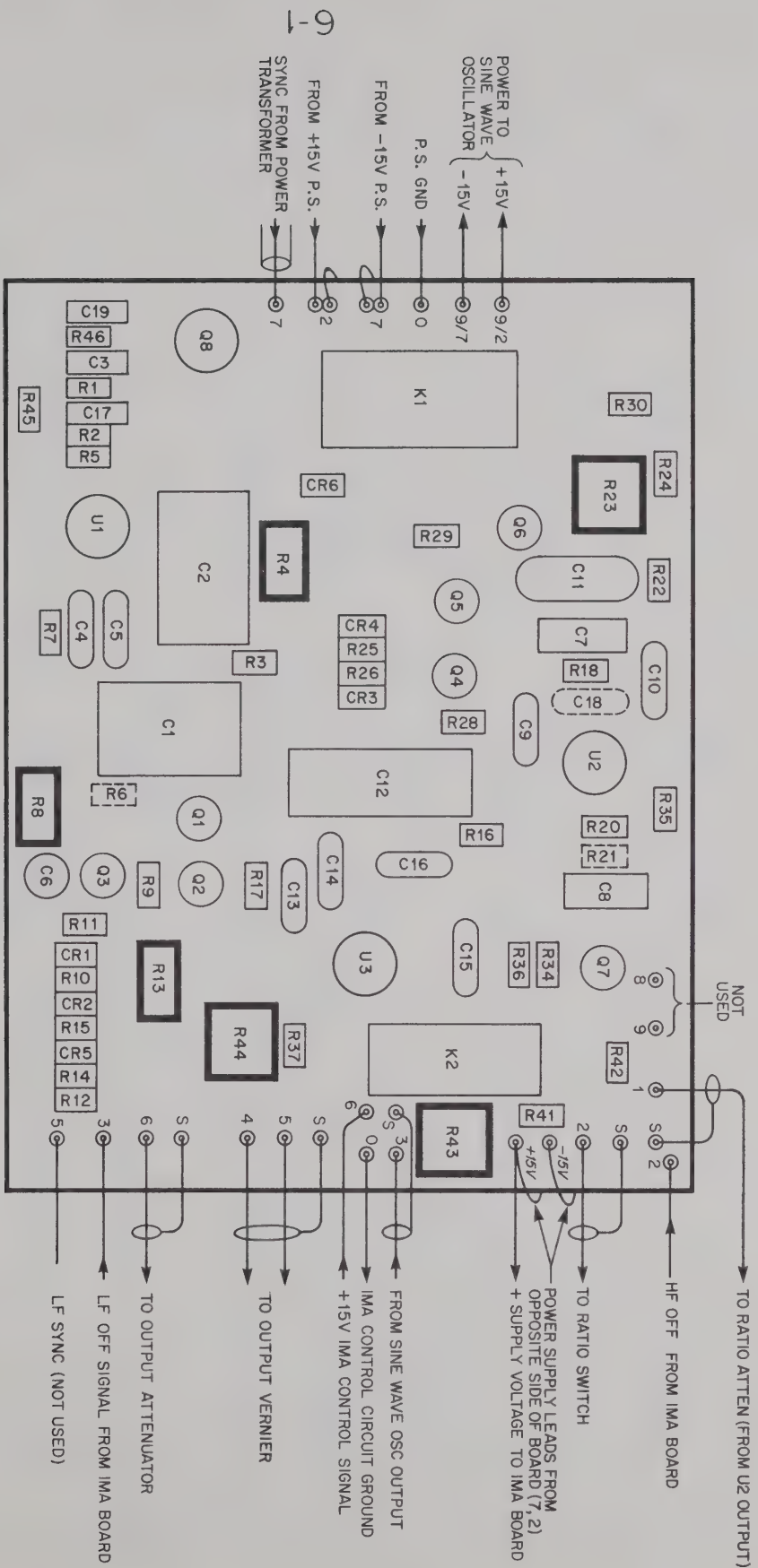
01700-30017 ASSY-PC, IM ANALYZER

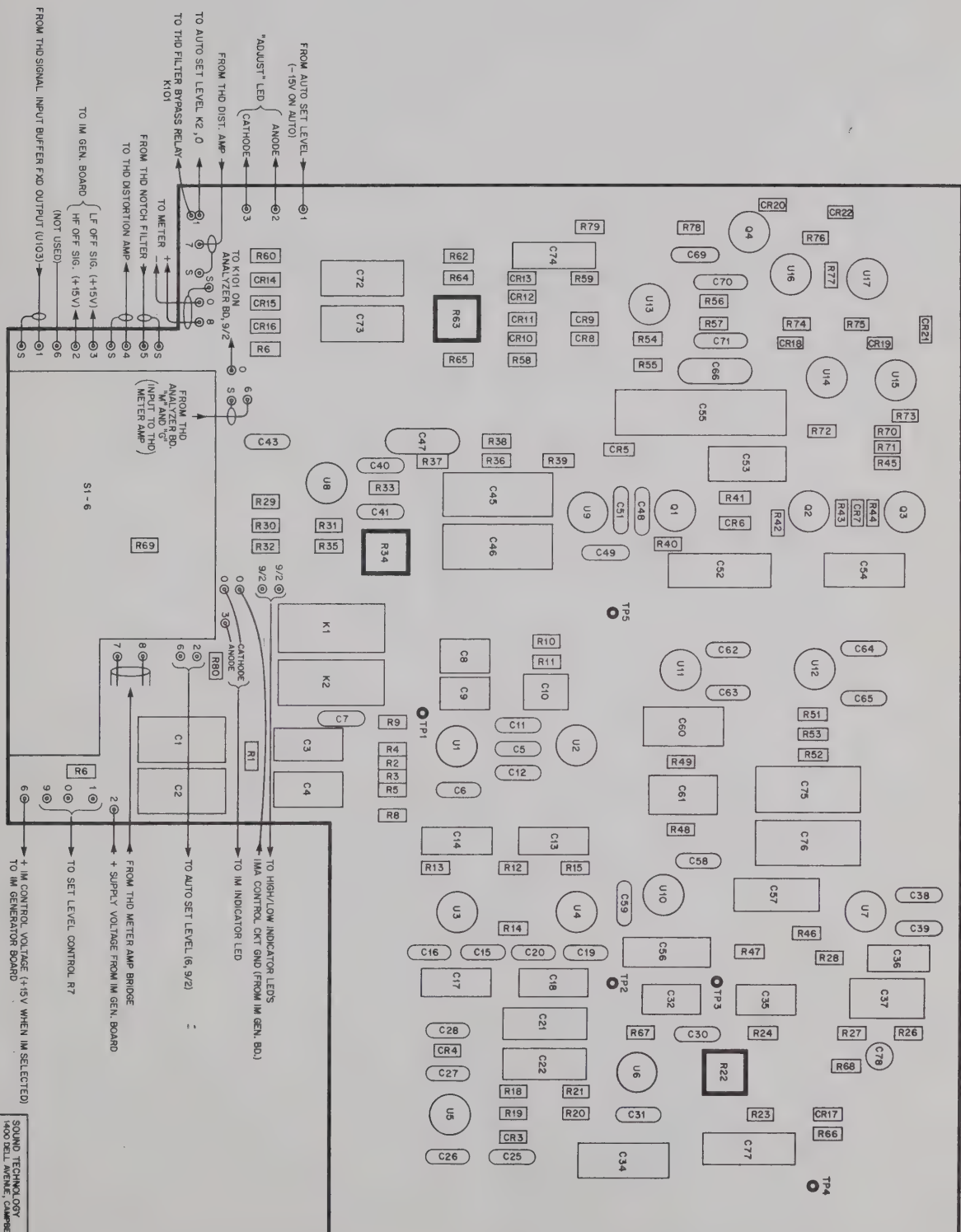
PART NO	DESCRIPTION	QTY	PART NO	DESCRIPTION	QTY
0005-0000	TRANS 2N3053 NPN SI	4.0			
	Q1-4				
0100-0001	IC-OP AMP 741	8.0			
	U2, 3, 4, 6, 7, 10, 11, 12				
0100-0014	IC-OP AMP 2605 GRADE 6 BLUE	2.0			
	U1, 9				
0100-0016	OP-AMP 301C	7.0			
	U5, 8, 13-17				
0200-0000	DIODE-GEN 1N914A SI	19.0			
	CR3-5, 7-22				
0205-0002	DIODE-ZENER 1N750 4.7V	1.0			
	CR6				
1015-0010	RES-FXD 10 1% 1/8W MF	3.0			
	R33, 64, 65				
1015-0019	RES-FXD 19.6 1% 1/8W MF	1.0			
	R8				
1015-0182	RES-FXD 182 1% 1/8W MF	1.0			
	R66				
1015-1100	RES-FXD 1K 1% 1/8W MF	5.0			
	R6, 23, 35, 36, 77				
1015-1187	RES-FXD 1.87K 1% 1/8W MF	1.0			
	R12				
1015-1200	RES-FXD 2K 1% 1/8W MF	2.0			
	R29, 30				
1015-1232	RES-FXD 2.32K 1% 1/8W MF	1.0			
	R38				
1015-1301	RES-FXD 3.01K 1% 1/8W	1.0			
	R75				
1015-1422	RES-FXD 4.22K 1% 1/8W MF	1.0			
	R24				
1015-1499	RES-FXD 4.99K 1% 1/8W MF	1.0			
	R20				
1015-1523	RES-FXD 5.23K 1% 1/8W MF	1.0			
	R14				
1015-1681	RES-FXD 6.81K 1% 1/8W MF	1.0			
	R10				
1015-1715	RES-FXD 7.15K 1% 1/8W MF	2.0			
	R27, 28				

PART NO	DESCRIPTION	QTY	PART NO	DESCRIPTION	QTY
2025-0004	CAP-FXD 0.02UF 1% 33V PLYSTR C3, 4, 32	3.0	1015-1392	RES-FXD 3.92K 1% 1/8W MF R7, 22	2.0
2025-0007	CAP-FXD 0.2UF 1% 100V FILM C37	1.0	1015-1464	RES-FXD 4.64K 1% 1/8W MF R10, 12, 25, 26	4.0
2025-0010	CAP-FXD .039UF 2.5% 33V PLYSTR C57	1.0	1015-1576	RES-FXD 5.76K 1% 1/8W MF R41	1.0
2025-0015	CAP-FXD .015UF 2.5% 63V PLYSTR C56	1.0	1015-1681	RES-FXD 6.81K 1% 1/8W MF R14, 28	2.0
2025-0017	CAP-FXD .056UF 2.5% 33V PLYSTR C1, 2	2.0	1015-2100	RES-FXD 10K 1% 1/8W MF R16	1.0
2025-0029	CAP-FXD .022UF 2.5% 63V PLYSTR C60	1.0	1015-2249	RES-FXD 24.9K 1% 1/8W MF R3	1.0
2025-0030	CAP-FXD .027UF 2.5% 63V PLYSTR C61	1.0	1015-2274	RES-FXD 27.4K 1% 1/8W MF R5	1.0
2040-0000	CAP-FXD 0.01UF 100V CERAMIC C5, 6, 11, 12, 15, 16, 19, 20, 25, 26, 30, 31, 38-41, 48, 49, 58, 59, 62-65	24.0	1100-0510	RES-FXD 510 5% 1/4W R36	1.0
2040-0002	CAP-FXD 0.1UF 25V CERAMIC C70, 71	2.0	1100-1100	RES-FXD 1K 5% 1/4W R6	1.0
2100-0000	CAP-FXD 4.7UF 10% 35V TANT C78	1.0	1100-1180	RES-FXD 1.8K 5% 1/4W R45	1.0
2100-0001	CAP-FXD 1UF 25V ELECT AL C35	1.0	1100-1330	RES-FXD 3.3K 5% 1/4W R34	1.0
2100-0003	CAP-FXD 10UF 25V ELECT AL C21, 22, 74	3.0	1100-1910	RES-FXD 9.1K 5% 1/4W R35	1.0
2100-0004	CAP-FXD 35UF 25V ELECT AL C53, 54, 72, 73	4.0	1100-2150	RES-FXD 15K 5% 1/4W R1, 2	2.0
2100-0005	CAP-FXD 50UF 25V ELECT AL C34, 77	2.0	1100-2180	RES-FXD 18K 5% 1/4W R46	1.0
2100-0006	CAP-FXD 100UF 25V ELECT AL C45, 46, 52, 75, 76	5.0	1100-2330	RES-FXD 33K 5% 1/4W R11	1.0
2100-0019	CAP-FXD 800UF 6V ELECT C55	1.0	1100-2390	RES-FXD 39K 5% 1/4W R29	1.0
3015-0007	SWITCH-PB, 4 STA 6P & 2 STA P-P S1-6	1.0	1100-2560	RES-FXD 56K 5% 1/4W R15	1.0
3105-0000	SOCKET-IC 8 PIN ROUND	17.0	1100-2750	RES-FXD 75K 5% 1/4W R30	1.0
3120-0000	CONN-SINGLE CONTACT, .093 PIN	21.0	1410-0002	RES-VAR 500 TRIMPOT CERMET R23	1.0
3120-5000	CONN-SINGLE CONTACT, .093 SOCKET	21.0	1410-0003	RES-VAR 1K TRIMPOT CERMET R43, 44	2.0
3150-0002	SPACER-PUSHBUTTON SW, DOGBONE	6.0	1410-0008	RES-VAR 1K TRIMPOT, STANDUP R8	1.0
3400-0002	RELAY-1 FORM A K2	1.0	1410-0009	RES-VAR 500 TRIMPOT, STANDUP R13	1.0
3400-0003	RELAY-2 FORM A K1	1.0	1410-0010	RES-VAR 5K TRIMPOT, STANDUP R4	1.0
8000-0000	PUSHBUTTON-WHITE	6.0	2000-0010	CAP-FXD 10PF 5% 500V MICA C13	1.0
01700-5017	PC BOARD-IM ANALYZER	1.0	2000-0056	CAP-FXD 56PF 5% 500V MICA C16	1.0
01700-30018 PC-ASSY					
IM SIGNAL GENERATOR					
PART NO	DESCRIPTION	QTY	PART NO	DESCRIPTION	QTY
0000-0001	TRANS 2N3644 PNP S1 Q1, 2, 4, 5, 7	5.0	2020-0013	CAP-FXD 0.033UF 10% 100V MYLAR C11	1.0
0005-0000	TRANS 2N3053 NPN SI Q8	1.0	2025-0001	CAP-FXD 0.002UF 1% 33V PLYSTR C7, 8	2.0
0020-0001	TRANS-FET VCR3P P-CHAN Q3, 6	2.0	2025-0006	CAP-FXD 0.1UF 1% 33V PLYSTR C1, 2	2.0
0100-0001	IC-OP AMP 741 U1	1.0	2040-0000	CAP-FXD 0.01UF 100V CERAMIC C4, 5, 9, 10, 14, 15	6.0
0100-0007	IC-OP AMP 2605 GRADE 2 RED U3	1.0	2100-0000	CAP-FXD 4.7UF 10% 35V TANT C6	1.0
0100-0014	IC-OP AMP 2605 GRADE 6 BLUE U2	1.0	2100-0006	CAP-FXD 100UF 25V ELECT AL C12	1.0
0200-0000	DIODE-GEN 1N914A SI CR1-6	6.0	2100-0020	CAP-FXD 1UF 50V ELECT TANT AXL C3, 17, 19	3.0
1005-2114	RES-FXD 11.4K 0.25% 1/8W MF R18, 20	2.0	3105-0000	SOCKET-IC 8 PIN ROUND	3.0
1005-2158	RES-FXD 15.8K 0.25% 1/8W MF R33, 42	2.0	3400-0001	RELAY-1 FORM C K2	1.0
1015-1100	RES-FXD 1K 1% 1/8W MF R17, 37	2.0	3400-0003	RELAY-2 FORM A K1	1.0
1015-1150	RES-FXD 1.5K 1% 1/8W MF R9, 24	2.0	8540-0004	SCREW 6-32 X 1/4 POZI PAN HD	2.0
			8542-0001	LOCKWASHER-EXT #6	2.0
			8702-0002	SPACER-THD. 6-32 3/8LG X 5/16OD	2.0
			01700-5018	PC BOARD-IM OSCILLATOR	1.0

01700-30021. ATTEN SWITCH
ASSEMBLY

PART NO	DESCRIPTION	QTY
1000-0005	RES-FXD 600. 0 . 1% 1/10 T2 R48	1. 0
1000-0006	RES-FXD 660. 0 . 1% 1/10 T2 R54	1. 0
1000-0007	RES-FXD 733. 3 . 1% 1/10 T2 R52	1. 0
1000-0008	RES-FXD 741. 6 . 1% 1/10 T2 R50	1. 0
1000-0009	RES-FXD 877. 5 . 1% 1/10 T2 R56	1. 0
1000-0010	RES-FXD 1. 297K 0. 1% 1/10W MF R55	1. 0
1000-0011	RES-FXD 5. 940K 0. 1% 1/10W MF R51, 53	2. 0
1000-0012	RES-FXD 6. 000K 0. 1% 1/10W MF R49	1. 0
3010-0005	SWITCH-ROTARY IM ATTEN S2	1. 0





MODEL 1700B
INTERMODULATION DISTORTION ANALYZER
OPTION 004

SOUND TECHNOLOGY

SOUND TECHNOLOGY
1400 Dell Avenue
Campbell, California 95008
U.S.A.
Telephone (408)378-6540

May, 1976

CONTENTS

SECTION		Page
I	GENERAL INFORMATION.	1-1
	1-1. INTRODUCTION.	1-1
	1-2. MEASUREMENT TECHNIQUE	1-1
	1-3. IMD OPTION.	1-1
II	OPERATION.	2-1
	2-1. CONTROLS AND INDICATORS	2-1
	2-2. OPERATING INSTRUCTIONS.	2-1
	2-3. TEST SET-UP.	2-1
	2-4. IM DISTORTION MEASUREMENT WITH 4:1 or 1:1 LF:HF AMPLITUDE RATIO	2-1
	2-5. IM DISTORTION MEASUREMENT WITH NON-STANDARD LF:HF RATIO	2-1
	2-6. IM DISTORTION MEASUREMENT WITH AUTO LEVEL SET	2-2
III	PRINCIPLES OF OPERATION.	3-1
	3-1. INTRODUCTION.	3-1
	3-2. IM SIGNAL SOURCE.	3-1
	3-3. IM ANALYZER	3-1
IV	MAINTENANCE.	4-1
	4-1. INTRODUCTION.	4-1
	4-2. TEST EQUIPMENT.	4-1
	4-3. PERFORMANCE CHECK	4-1
	4-4. INTRODUCTION	4-1
	4-5. INTERMODULATION RESIDUAL DISTORTION TEST	4-1
	4-6. ADJUSTMENT AND CALIBRATION PROCEDURE.	4-2
	4-7. IM GENERATOR	4-2
	4-8. OSCILLATOR ADJUSTMENTS	4-2
	4-9. 4:1 DIVIDER CONFIDENCE CHECK	4-3
	4-10. IM ANALYZER.	4-3
	4-11. PEAK DETECTOR AND THD SIGNAL LEVEL ADJUSTMENTS	4-3
	4-12. ABSOLUTE VALUE DETECTOR OFFSET NULL.	4-3
	4-13. IMD MEASUREMENT CALIBRATION.	4-4
	4-14. AUTO SET LEVEL ADJUSTMENT.	4-5
	4-15. TROUBLESHOOTING	4-5
	4-16. SYMPTOM/CAUSE TABLE	4-5
	4-17. COMPONENT REPLACEMENT-CALIBRATION AND ADJUSTMENT.	4-5
	4-18. ACCESS TO LOW-DISTORTION OSCILLATOR	4-5
V	MODIFICATIONS FOR EUROPE AND JAPAN	5-1
	5-1. DIN (EUROPE).	5-1
	5-2. 50/60 Hz OPERATION (JAPAN).	5-1
VI	DIAGRAMS.	6-1
	6-1. COMPONENT LOCATION, IM GENERATOR BOARD.	6-1
	6-2. SCHEMATIC DIAGRAM, IM GENERATOR	6-2
	6-3. COMPONENT LOCATION, IM ANALYZER BOARD	6-3
	6-4. SCHEMATIC DIAGRAM, IM ANALYZER.	6-4
VII	SPARE PARTS.	7-1
	7-1. INTRODUCTION.	7-1
	7-2. ORDERING INFORMATION.	7-1

WARRANTY

All new Sound Technology products are warranted against defects in materials and workmanship for one year from the date of delivery. Any instrument or component that is found to be defective within the warranty period after examination by Sound Technology or an authorized representative thereof will be repaired or replaced without charge for labor or material. No other warranty is expressed or implied. We are not liable for consequential damages.

Before returning a product to Sound Technology for service, authorization must be obtained from the factory. For products not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay. Please include instrument model number and serial number with all requests for parts or service to facilitate the fastest possible response.

All products returned to the factory must be shipped prepaid. For products under warranty, Sound Technology will pay for shipment back to the customer.

1700B Modification Notice

0-1 INTRODUCTION

The Sound Technology Model 1700B Distortion Measurement System, first introduced in January, 1976 incorporates two design refinements not found on the 1700A. These refinements consist of two momentary front panel switches; one which replaces the oscillator signal at the SIGNAL OUTPUT jack with a floating short, and another which allows the operator to monitor the oscillator output signal with either the AC Voltmeter or Distortion Analyzer.

The reader should be aware that the terms, "1700A" and "1700B" are interchangeable as used throughout this manual.

0-1 OPERATION

a. Signal Off Switch

When depressed, this switch replaces the front panel SIGNAL OUTPUT jack with a floating short circuit. This enables the user to make signal to noise ratio measurements without the necessity of disconnecting cables.

b. Analyzer Select Switch

When this switch is depressed, the INPUT connectors are temporarily isolated and instrument is now monitoring the signal that appears at the SIGNAL OUTPUT Jack. The user may select either volts/power or DISTORTION function pushbuttons and measure the oscillator output voltage or residual distortion.

SECTION I GENERAL INFORMATION

1-1. INTRODUCTION

This supplement provides operating and service information for the Model 1700B Intermodulation Distortion (IMD) Analyzer Option 004. The information contained in the supplement pertains to the IMD option only. Consult the Model 1700B manual for additional information regarding primary power requirements, grounding details, and cabling instructions.

1-2. MEASUREMENT TECHNIQUE

The IMD option is based on the SMPTE (Society of Motion Picture and Television Engineers) method to measure IMD whereby a large 60-Hz signal is combined with a small 7 kHz signal in a four-to-one amplitude ratio. Passing this combined (composite) signal through a non-linear device results in the appearance of new frequencies above and below 7 kHz in multiples of 60 Hz. The effect of these new frequencies is amplitude modulation of the 7 kHz signal, which can be detected.

The component parts of the IMD option include a signal source and an IM analyzer. The signal source generates a low-frequency sinusoid and a high-frequency sinusoid that are mixed and fed to the input of the device under test. Level controls are provided so that the amplitude of the composite signal can be set to the desired level. The signal from the output of the device under test is then fed back to the analyzer circuits of the IMD meter. A high-pass filter removes the low frequency, leaving only the high frequency together with any possible low-frequency modulation. This signal is input to an envelope detector (or absolute value detector) resulting in only the rectified carrier with its amplitude varying at a low-frequency rate. A low-pass filter removes the carrier, leaving only the modulation products. The amount of these products is indicated on the meter in terms of percentage of the high-frequency signal passed through the high-pass filter.

1-3. IMD OPTION

This option adds IMD measurement capability to the Model 1700B Distortion Measurement System. It employs the IMD measurement technique described above and in addition provides the user with a number of unique operating features. These are detailed in the following paragraphs.

The IM signal source contains a 60 Hz low-frequency oscillator and a 7 kHz high-frequency oscillator. Controls on the front panel permit a rapid selection of a composite test signal having fixed low-frequency to high-frequency ratios of 4:1 or 1:1 plus a variable ratio of greater than 16:1 to 1:1. The amplitude of the test signal is controlled by an accurate 10 dB-per-step attenuator with a range of 70 dB and by a 10 dB vernier control. The amplitude of the composite test signal can be measured directly in peak equivalent rms single tone voltage or power. This parameter, specified by the Institute of High Fidelity for IMD measurements, is defined as the voltage or power level of a sine-wave signal having a peak value equal to the peak value of the composite IM test signal. The ability to make this measurement eliminates the need for meter reading conversion or matching oscilloscope waveforms.

The IMD option combines with the Model 1700B input circuits to provide the option with a differential input configuration. In operation, the IM analyzer is capable of measuring IMD at all power levels between one milliwatt and ten kilowatts across eight ohms, with a residual intermodulation distortion of less than .0025 percent (.004 percent at one milliwatt). Meter sensitivity ranges from 100 percent to .01 percent full scale. The analyzer can also measure the LF-to-HF voltage ratio of the IM test signal from (a) input to the device under test or (b) output from the device to the analyzer. When the analyzer is used with a Model 1700B fitted with Auto Set Level (Option 003) it is possible to perform IMD testing within the range of one milliwatt to ten kilowatts without adjusting the SET LEVEL control. This feature facilitates testing volume compressors/expanders and similar non-linear devices. Operation with the Auto Set Level option also permits the user to switch from Total Harmonic Distortion (THD) testing to IMD testing without having to make adjustments to compensate for the frequency response of the device under test.

SECTION II OPERATION

2-1. CONTROLS and INDICATORS

The data sheet at the front of this supplement describes the controls and indicators on the front panel of the Model 1700B IMD option. The following provides additional explanatory information.

- a. OFF pushbutton -- Switches system measurement mode from intermodulation distortion (IMD) to total harmonic distortion (THD). System is in THD mode when pushbutton is in.
- b. PK EQUIV V/PWR pushbutton -- Selects measurement mode whereby meter displays amplitude of IM test signal in peak equivalent rms single tone voltage or power.
- c. OUTPUT ATTEN control -- Varies level of IM test signal in 10 dB steps.
- d. OUTPUT VERNIER control -- Varies level of IM test signal over a 10 dB range.

NOTE

When the IMD option is installed in the 1700B, the output signal is routed through the output attenuator and output vernier at all times, regardless of whether the instrument is in the IMD or THD mode of operation.

- e. RATIO slide switch -- Selects desired low-frequency to high-frequency amplitude ratio of composite IM test signal. Two fixed ratios (4:1 and 1:1) are available. The VAR (variable) position allows selection of a ratio variable from greater than 16:1 to 1:1 with adjacent HF AMPL control.
- f. HF AMPL control -- Adjusts LF:HF ratio of composite IM test signal when RATIO slide switch is set to VAR position. MAX setting (fully clockwise) selects a 1:1 ratio.
- g. HF ONLY pushbutton -- Turns off low-frequency oscillator. When pushbutton is in, only the high-frequency signal is present at SIGNAL OUTPUT connector.
- h. LF ONLY pushbutton -- Turn off high-frequency oscillator. When pushbutton is in, only the low-frequency signal is present at the output.
- i. SET LEVEL pushbutton -- Selects set level function whereby meter displays amplitude of reference high-frequency signal required for IMD measurement.
- j. ADJUST control -- Adjusts amplitude of reference signal for IMD measurement.
- k. ERROR indicator -- Lights during Auto Set Level (Option 003) operation when adjacent ADJUST control is incorrectly set. Correct setting is achieved by turning ADJUST control until indicator is extinguished. Light will also go out if composite input signal is either below 20% or greater than 150% of full scale.
- l. IMD pushbutton -- Selects intermodulation distortion measurement function.
- m. IM indicator -- Lights when system is in IMD measurement mode i.e., whenever PK EQUIV V/PWR, SET LEVEL, or IMD pushbutton is in and HF ONLY and LF ONLY pushbuttons are out.

2-2. OPERATING INSTRUCTIONS

2-3. TEST SET-UP

Refer to Section I of the Model 1700B manual and connect the equipment as shown in Figure 1-1. Also, read and follow the instructions given in paragraphs 1-6 through 1-9 of the same manual before making any IMD measurements. Sync the test oscilloscope to the line frequency and set sweep speed to 5 msec/div.

2-4. IM DISTORTION MEASUREMENT WITH 4:1 or 1:1 LF:HF AMPLITUDE RATIO.

To measure intermodulation distortion with a 4:1 LF:HF composite signal, proceed as follows:

- a. Set Model 1700B ADJUST control to CAL position or AUTO (for auto set level).
- b. Set IM RATIO switch to 4:1.
- c. Press PK EQUIV V/PWR pushbutton.

- d. Ensure that HF ONLY and LF ONLY pushbuttons are in the out position.
- e. Set Model 1700B INPUT switch to desired range setting. Adjust OUTPUT ATTEN switch and OUTPUT VERNIER control for desired rms peak equivalent single tone voltage/power reading. Ensure that meter indication is in upper two-thirds of scale.
- f. Push IM SET LEVEL pushbutton and turn adjacent ADJUST control until meter reads full scale. Omit this step if using auto set level. (See Section 2-6)
- g. Push IMD pushbutton. Adjust Model 1700B RATIO switch until meter deflection is in upper two-thirds of scale, if possible.
- h. Read distortion in either percent or dB as indicated by meter deflection and RATIO switch range setting. For example, if meter reads .67 and RATIO range is 0.1 PERCENT, distortion reading is .067%.
- i. To switch the 1700 to the THD mode, push the OFF pushbutton on the IM panel.

NOTE

It is normal for the 1700B oscillator to go through a few cycles of stabilization when switching from the IMD mode to the THD mode. This is due to the power supply for the main oscillator being turned off when in the IMD mode.

To make an IM distortion reading with a 1:1 LF:HF signal, set the IM RATIO switch to 1:1 and then carry out steps c through i above. Signal output level will increase about 55% when switching from 4:1 to 1:1.

2-5. IM DISTORTION MEASUREMENT WITH NON-STANDARD LF:HF RATIO

To perform an IM distortion measurement using a LF:HF amplitude ratio other than 4:1 or 1:1, proceed as follows:

- a. Set Model 1700B ADJUST control to CAL position or AUTO (for auto set level).
- b. Set IMD option controls as follows:
 PK EQUIV V/PWR pushbutton -----IN
 IM RATIO switch -----VAR
 LF ONLY pushbutton -----IN
 HF ONLY pushbutton -----OUT
 ANALYZER SELECT -----INPUT or GENERATOR
OUTPUT AS DESIRED
- c. Adjust Model 1700B INPUT switch, and OUTPUT ATTEN and OUTPUT VERNIER controls for a full-scale reading on an appropriate meter voltage scale.
- d. Calculate inverse of desired LF:HF ratio. For example if desired ratios is 16:1, inverse would be 1:0.0625, LF:HF.
- e. Set LF ONLY button to out position and press HF ONLY pushbutton. Now adjust HF AMPL control until meter indicates relative high-frequency level determined in step d. For example, for a 16:1 ratio, the HF AMPL control should be adjusted to obtain a meter reading of .0625 of full scale. The INPUT switch can be stepped down to obtain a more accurate reading of the high-frequency signal. For the 16:1 ratio, the INPUT switch can be stepped down two positions, adjusting the meter reading to .625 on the 0-1.0 meter scale.
- f. Now set HF ONLY pushbutton to out position and follow steps c through i of paragraph 2-4.

2-6. IM DISTORTION MEASUREMENTS WITH AUTO SET LEVEL SET

To make an IM distortion measurement using a Model 1700B fitted with the Auto Set Level option proceed as follows:

- a. Turn Model 1700B ADJUST control fully counter-clockwise past CAL position until detent position is reached. This activates the Auto Set Level circuit. The gain of the intermodulation analyzer must be within a certain range for the Auto Set Level to function correctly. The ERROR indicator lights whenever the intermodulation analyzer gain is not within the necessary gain "window". In this event, turn the IM ADJUST control until the ERROR indicator is extinguished. For a further explanation of this see section 3-3.
- b. Follow steps described in paragraphs 2-4 and 2-5.
- c. Observe ERROR indicator; rotate IM ADJUST control until an off "window" is found; then set the IM ADJUST control to the window's approximate center.
- d. To switch the 1700B to the THD mode, push the OFF pushbutton on the IM panel. (It is normal for the 1700B oscillator to go through a few cycles of stabilization when switching from the IMD mode to the THD mode.)

SECTION III PRINCIPLES OF OPERATION

3-1. INTRODUCTION

This section contains a functional description of the IM signal source and the IM analyzer - the principle components of the IMD option. For a description of the IMD measurement technique employed by the option and a description of its operating features, refer to Section I of this supplement.

3-2. IM SIGNAL SOURCE

Refer to the schematic diagram in Section VI of this manual. The IM signal source consists of two Wien bridge RC oscillators, a summing amplifier, and an output attenuator. The low-frequency (LF) oscillator operates at 60 Hz and is synced to the line frequency. The oscillator has an output amplitude of 6.3 volts rms (nominal). The high-frequency (HF) oscillator operates at 7 kHz and also has an output of 6.3 volts rms (nominal). The HF oscillator is optimized for maximum amplitude stability. The signals from both oscillators are coupled to the input of a summing amplifier that supplies the composite IM test signal.

The amplitude ratio of the two frequencies is controlled by varying the amplitude of the HF signal input to the summing amplifier. When the front-panel RATIO slide switch is set to the 1:1 position, the full 6.3 volts rms (nominal) HF signal is delivered to the summing amplifier. When the RATIO slideswitch is set to the 4:1 position, a resistive divider attenuates the HF signal by a factor of four, so that the HF level at the summing amplifier output is one-quarter that of the LF level. When the RATIO switch is set to VAR position, a potentiometer controlled by the front-panel HF AMPL knob permits the level of the HF input to the summing amplifier to be set to any level between zero and 6.3 volts rms.

The IM signal source is operable only when the IMD switch is set to the IM (out) position. This disconnects dc operating voltage from THD low-distortion oscillator and allows the 60-Hz and 7 kHz oscillators to turn on. When the IMD OFF switch is pressed, dc power is connected to the THD low-distortion oscillator and at the same time dc voltages are applied to the two IM oscillator circuits biasing them to an off state.

The output attenuator consists of a ladder-type step attenuator in series with a 10-dB "L" attenuator. The ladder section has attenuation steps of 0, 20, 40 and 60dB, changing at every second setting of the front-panel OUTPUT ATTEN switch. Thus, the attenuation of the ladder section is 0 dB for the 0-dB and 10-dB switch settings, 20 dB for the 20-dB and 30-dB settings etc. The 10-dB "L" section is bypassed on the 0-, 20-, 40-, and 60-dB switch settings and connected in series with the ladder section on the 10-, 30-, 50-, and 70-dB settings. This provides the output attenuator with a range of 0 dB to 70 dB in 10-dB steps. The attenuator has a constant output impedance of 600 ohms.

3-3. IM ANALYZER

The following is a discussion of the IM analyzer board and Model 1700B circuits that comprise the IM analyzer. Refer to the schematic diagrams in the Model 1700B manual and Section VI of this manual for circuit details.

The IM test signal from the device under test is connected via the Model 1700B INPUT terminals to the INPUT attenuator and from there to the differential input buffer and differential-to-single-ended buffer. The output signal from the buffer amplifier (in the range of 1 to 3.16 peak equivalent volts), is coupled via a passive 2-pole high-pass filter to the input buffer. The filter attenuates the 60Hz component of the IM signal by approximately 26 dB. The gain of the input buffer is variable from 2 to 100 by the front panel IM ADJUST control. This allows the amplitude of the signal at the output of the IM buffer (TP1) to be set to approximately 3.16 volts, the correct set level for the IM distortion measurement.

From the IM input buffer, the signal is connected to an active 7-pole, high-pass filter having a cut-off frequency of 2kHz. This attenuates the 60 Hz by a further 210 dB, leaving only a pure 7 kHz sine wave plus any amplitude modulation caused by the non-linearity of the device under test. From here, the signal is connected to an absolute value detector that rectifies the 7 kHz waveform.

When the IM SET LEVEL pushbutton is pressed the output of the absolute value detector, which is essentially a dc level representing the amplitude of the 7 kHz component of the test waveform, is connected through switch S3 to the front panel meter. This permits monitoring the amplitude of the HF component of the input signal for Set-Level adjustments.

The output of the absolute value detector is also coupled to a 7-pole, low-pass filter with a cut-off frequency of 500 Hz. This removes the 7 kHz component from the rectified signal, leaving only the intermodulation products. The output from the low-pass filter is connected to the THD RATIO attenuator and distortion amplifier through OFF switch, S1. The amplifier output is 31.6 mV full scale for each attenuator setting.

An IM measurement is made by pressing the IMD pushbutton, connecting the distortion amplifier output via the auto set level option and the IM meter amplifier to the front panel meter. If the auto set level option is not fitted, the signal is jumpered directly from the distortion amplifier to the IM meter amplifier. Also, when the system is in the IM measurement mode, a relay bypasses the 400 Hz and 80 kHz filters located between the distortion amplifier output and the input of the auto set level circuit. This relay is on the THD analyzer board and activated through a contact on relay K1, located on the IM analyzer board.

When the PK EQUIV V/PWR pushbutton switch S2 is pressed, the output of the THD meter preamplifier is connected via the IM peak detector to the front-panel meter. The THD meter preamplifier has a 31.6 mV full scale output on each range of the INPUT attenuator and the peak detector buffer has a gain of approximately 22. This changes the 31.6 mV full scale signal to approximately one volt peak at the peak detector input and causes one milliampere of current to be supplied to the meter for a full scale reading.

The peak detector, consisting of U9 and associated components, operates as a summing amplifier. The input to the circuit may be considered to be at the junction of capacitor C46 and resistor R36. The detector responds to negative input peaks. Meter current (average one milliampere full-scale) flows back to the summing point through resistor R38. If the peak negative input current through R36 exceeds the feedback current, the output of U9 will go positive and add charge to C55 through emitter-follower Q1. This added charge will then increase the average meter current: As long as the output of U9 swings positive each cycle, Q2 will conduct each cycle, thus holding down the voltage on C54 and preventing Q3 from conducting. If the peak input current does not exceed the feedback current, the output of U9 remains clamped negative by diode CR5 at approximately 0.7 volts. In this event, the voltage on C54 will rise, and Q3 will conduct to quickly reduce the charge on C55. This allows the meter to respond quickly to a decreasing signal level.

The Auto Set Level option provides automatically controlled gain at the output of the distortion amplifier to compensate for a 10 dB range of input signal. For THD measurements, gain is simply controlled by the input signal level, which is the reference for the measurement. For IMD measurements, the reference for the measurement is not the input signal (total composite signal) but rather the level of the high-frequency (7 kHz) component. Yet, the input signal level indicated on the front panel meter (pk equiv v/pwr) during the measurement is proportional to the peak value of the composite signal.

For the Auto Set Level to operate over a 10 dB range of peak equivalent volt/power level, it is necessary that the SET LEVEL control be adjusted such that when in the SET LEVEL mode, the meter reads within approximately plus or minus 2 dB of the meter deflection when in the PK EQUIV V/PWR mode. This places the output of the absolute level detector in the proper range to control the auto set level circuit. Once the SET LEVEL control is properly set, no further adjustment is required unless the low-to-high frequency ratio at the analyzer input is changed. Now, the 7 kHz level (absolute value detector output) tracks the input signal level (peak detector output).

In order to avoid possible readout error due to an incorrectly adjusted SET LEVEL control, a "window" detector is incorporated in the IM analyzer. This circuit consists primarily of operational amplifiers U14 and U15. U14 turns on ADJUST light-emitting diode CR24 if the output of the absolute value detector, as divided down by resistors R68, R70 and R71, exceeds the output of the peak detector by approximately 2.5 dB. The peak

detector output is derived from the voltage developed across resistor R38. Conversely, U15 turns on the ADJUST indicator if the output of the peak detector exceeds the output of the absolute value detector, as divided down and appearing at pin 3 of U15, by approximately 2 dB.

Operational amplifiers U16 and U17 act in a similar manner to disable the ADJUST indicator (by absorbing the drive current through R79) if the peak equivalent volt power reading is much too low (less than 20 percent of full scale), or too high (greater than 150 percent of full scale). Here the peak detector output is simply compared to dc levels. Q4 is used to turn off the ADJUST indicator when the instrument is not in the auto mode of operation. If the auto set-level option is not installed, R79 is removed.

The reader may be interested to know that in the U17/U18 comparator circuit, diode CR22 is a redundant component. If the output of U17 goes negative, it pulls the output of U16 negative through the pin 8 connections. Therefore CR22 may be used as a spare diode.

SECTION IV MAINTENANCE

4-1. INTRODUCTION

This section provides a performance check, adjustment and calibration procedures, and troubleshooting information for the IMD option.

4-2. TEST EQUIPMENT

Recommended test equipment for performance checking and troubleshooting is listed in Table 4-1. Test instruments other than those described can be used provided their specifications equal or exceed those listed.

Table 4-1. Required Test Equipment

TYPE	REQUIRED SPECIFICATIONS	USE	RECOMMENDED INSTRUMENT
AC-DC DIGITAL VOLTMETER	Range: 1mV to 2V Accuracy: 0.1% \pm 1 digit	Calibration	Fluke Model 8000A
Audio Generator	Frequency Range: to 8 kHz	Calibration	Sound Technology Model 1700 B or 1400A
OSCILLOSCOPE	Bandwidth: 500 kHz Deflection Factor: 5 mV/div Number of Channels: 2	Calibration and Troubleshooting	Hewlett-Packard Model 1200A or Philips Model 3232

4-3. PERFORMANCE CHECK

4-4. INTRODUCTION

The performance check for the IMD option consists of an intermodulation residual distortion test. If the performance limits are exceeded in the following paragraph, refer to the troubleshooting hints in paragraph 4-16.

4-5. INTERMODULATION RESIDUAL DISTORTION TEST

- a. Connect equipment in test configuration shown in Figure 1-1 of Model 1700B manual except connect a cable from SIGNAL OUTPUT/GENERATOR OUTPUT connector of Model 1700B directly to its INPUT terminals. Set Model 1700B ADJUST control to CAL position.

- b. Set IMD option controls as follows:

IM RATIO switch -----4:1
HF ONLY pushbutton -----out
LF ONLY pushbutton -----out
OUTPUT ATTEN switch -----0 dB
OUTPUT VERNIER control -----max CW

- c. Press PK EQUIV V/PWR pushbutton and set INPUT switch to 3 VOLTS range.
d. Press IMD SET LEVEL pushbutton and rotate adjacent ADJUST control for a full-scale reading on meter.
e. Press IMD pushbutton and set RATIO switch to -80 dB/.01 PERCENT range. Check that meter reading is .0025% or less.

4-6. ADJUSTMENT AND CALIBRATION PROCEDURE

This procedure should be performed whenever the results of the performance check (Paragraph 4-3) clearly establish the need to do so. After successfully performing in sequence the procedure in Paragraphs 4-7 through 4-15, the IMD option is considered to be calibrated.

NOTE

When performing this procedure ensure that only the equipment and cables specified are connected to the instrument.

4-7. IM GENERATOR

4-8. OSCILLATOR ADJUSTMENTS

- a. Set front panel controls as follows:

PK EQUIV V/PWR pushbutton -----in
HF ONLY pushbutton -----out
LF ONLY pushbutton -----in
RATIO switch -----1:1
OUTPUT VERNIER -----max CW
OUTPUT ATTEN switch -----0dB
FAST RESPONSE/LOW DISTORTION switch -----Fast Response
THD ADJUST control -----CAL

(Ignore an indicated overload condition) Remove sync from LF oscillator either by removing connection to power transformer (#7 on Generator Board) or by lifting one end of C19. Connect SIGNAL OUTPUT to a scope with horizontal sweep (5 ms/cm) synced to power line. Adjust R4 for a stationary pattern (LF oscillator running at line frequency). It may be necessary to adjust FET bias (R8) to keep oscillator running as R4 is adjusted. Restore LF osc. sync.

- b. Connect a cable between SIGNAL OUTPUT connector and INPUT terminals.

LF ONLY pushbutton -----out

- c. Measure Q6 gate voltage (an easy place to measure is at C11, .033 uf.). Allowable range is 1.0 to 2.0 Vdc. If out of range, adjust R23 for a reading 1.5 Vdc. Isolate gate voltage from voltmeter probe with a 10 K ohm resistor.
- d. Measure Q3 gate voltage (an easy place to measure is at collector of Q2. Don't forget 10 K isolation!). Allowable range is 1.0 to 2.0 Vdc. If out of range, adjust R8 for a reading of 1.5 Vdc.
- e. Press HF ONLY pushbutton. Adjust OUTPUT VERNIER control until front panel meter reads exactly full scale.

- f. Change front panel controls as follows:

HF ONLY pushbutton -----out
LF ONLY pushbutton -----in

- g. Without changing setting of OUTPUT VERNIER control, carefully adjust R13 until front panel meter indicates same full-scale reading obtained in Step C above.
- h. Repeat Step d above. If it was necessary to readjust R8, repeat Step g.

4-9. 4:1 DIVIDER CONFIDENCE CHECK

- a. Change front panel controls as follows:

INPUT switch -----3V
RATIO switch -----4:1

- b. Adjust OUTPUT VERNIER (and/or R44) for a front panel meter reading as close as possible to 2.40 Vac.
- c. Change front panel controls as follows:

HF ONLY pushbutton -----in
LF ONLY pushbutton -----out
INPUT switch -----1 V

- d. Check that front panel meter reads $0.60 \pm .02$ V.

4-10. IM ANALYZER

4-11. PEAK DETECTOR AND THD SIGNAL LEVEL ADJUSTMENTS

- a. Connect DVM in parallel with cable connected between SIGNAL OUTPUT connector and INPUT terminals.

- b. Change front panel controls as follows:

HF ONLY pushbutton -----out
LF ONLY pushbutton -----in

- c. Adjust OUTPUT VERNIER and OUTPUT ATTEN controls (and/or R44) for DVM reading of 0.800 Vac.

- d. Change front panel controls as follows:

HF ONLY pushbutton -----out
LF ONLY pushbutton -----out

- e. Adjust R34 on IM analyzer board for an exact full-scale reading on front panel meter.

- f. Change front panel controls as follows:

INPUT switch -----3V
OUTPUT ATTEN switch -----0 dB
OUTPUT VERNIER -----max CW

- g. Adjust R44 (IM generator board) for a full-scale reading on front panel meter.

4-12. ABSOLUTE VALUE DETECTOR OFFSET NULL

- a. Remove input signal and set INPUT switch to 3V.

- b. Connect DVM between TP4 and ground (negative end of C34).
- c. Set DVM to its most sensitive range.
- d. Adjust R22 for DVM reading of less than $\pm .003\text{Vdc}$.

4-13. IMD MEASUREMENT CALIBRATION

- a. Connect a cable between SIGNAL OUTPUT and the INPUT terminals with the high side of the SIGNAL OUTPUT connected to the + INPUT terminal.
- b. Connect a 47 kilohm resistor to the + INPUT terminal.
- c. Connect an external audio oscillator between the -INPUT terminal and the floating end of the 47 kilohm resistor.
- d. Set front panel controls as follows:

```

PK EQUIV V/PWR -----in
RATIO -----1:1
HF ONLY -----in
LF ONLY -----out
OUTPUT ATTEN -----0dB
INPUT -----1 Volt Range
RATIO -----40dB(1%)
THD ADJUST -----CAL

```

- e. Connect vertical input of oscilloscope to DISTORTION OUTPUT. Set controls as follows:

```

Vertical Sensitivity -----20 mV/cm
Sweep -----5 ms/cm
Sync -----Internal

```

- f. Set external audio oscillator frequency to approximately 7 kHz.
- g. With output of external oscillator reduced to zero, adjust OUTPUT VERNIER for 1700B meter reading as close to exact full scale as possible.
- h. Change front panel controls as follows:

```

OUTPUT ATTEN -----70 dB
LF ONLY -----in
INPUT -----.01 volt range

```

Adjust output of external oscillator for a meter reading as close to exact full scale as possible.

- i. Change front panel controls as follows:

```

LF ONLY -----out
OUTPUT ATTEN -----0dB
INPUT -----3 Volt range

```

Adjust the frequency of the external oscillator for a 10 to 15 ms period of the sinc wave appearing on the scope.

Adjust IM SET LEVEL control for an exact full scale reading on the meter.

- j. Depress IMD pushbutton. Adjust R63 on the IM Analyzer board for an exact full scale reading.

4-14. AUTO SET LEVEL ADJUSTMENT

- a. Turn THD ADJUST control to AUTO position. Adjust R6 on the auto set level board for an exact full-scale (1.00%) reading.
- b. Switch INPUT switch to 10 volt range. Check that reading is $1.00 \pm .02\%$.

4-15. TROUBLESHOOTING

Before attempting to troubleshoot the IMD Option ensure that the fault is with the option and not caused by the test setup or associated equipment. The performance check (Paragraph 4-3) enables this to be determined without having to remove the covers.

If an abnormal condition is observed during the performance check, table 4-2 will suggest remedies. However, before proceeding with detailed troubleshooting, note the troubleshooting hints contained in paragraph 3-29 of the Model 1700B Manual.

4-16. SYMPTOM/CAUSE TABLE

Table 4-2 contains symptoms of IMD option malfunctions and provides diagnostic tests for the location of these faults. Following the repair of a defective component, refer to paragraph 4-1 for instructions regarding any necessary calibration and/or adjustment procedures.

Table 4-2. IMD Symptom-Cause Table

Symptom	Probable Cause	Diagnostic Test
Abnormally high level of residual IM distortion, distortion product is random noise.	7 kHz oscillator amplitude instability, Q6 gate voltage out of adjustment.	Measure dc level at gate of Q6 on IM analyzer board. Reading should be between 1.0 and 2.0 Vdc.
Abnormally high level of residual IM distortion, distortion product is multiple of 60-Hz	(1) Nonlinearity in IM generator summing amplifier U3, IM analyzer buffer U1. (2) Nonlinearity in THD buffers U101, U102, U103.	(1) Replace U3, U1. (2) Replace U101, U102, U103
Amplitude of 60-Hz oscillator is unstable, or oscillator is not synced to line.	Q3 gate voltage out of adjustment.	Measure dc level of gate of Q3 on IM generator board. Reading should be between 1.0 and 2.0 Vdc. Check freq. adjustment per 4-8a.

4-17. COMPONENT REPLACEMENT - CALIBRATION AND ADJUSTMENT

If U1 or U2 in the generator section are replaced, do the oscillator adjustments, section 4-8. In general, changing IC's in the analyzer section do not require re-adjustment. The exception is U6 in the Absolute Value Detector. Changing U6 would require the zero adjustment at TP4, section 4-12.

4-18. ACCESS TO LOW-DISTORTION OSCILLATOR

In order to reach the low-distortion oscillator assembly, it is necessary to move the IM analyzer board mounted above it. To reach the oscillator, proceed as follows:

- a. Remove top cover from instrument.

- b. Locate metal shield on which IM analyzer board is mounted.
- c. Remove four screws attaching this shield to instrument. Do not remove screws securing IM analyzer board to shield.
- d. Carefully move shield back until pushbuttons on board clear rear of front panel.
- e. Move shield until it is located vertically above center of instrument. Insert upper edge of instrument's center divider into slot on edge of IM analyzer shield. This holds board in a position that permits access to oscillator.
- f. Replace IM analyzer board following reverse procedure.

SECTION V MODIFICATIONS FOR EUROPE AND JAPAN

5-1. DIN (EUROPE)

- a. The Low Frequency Oscillator is set at 250 Hz and is not synchronized with the power line. The High Frequency Oscillator is at 8 kHz. The IM measurement then conforms to DIN 45403, Page 4 - "Measurement of non-linear distortion in electroacoustics; intermodulation method", and DIN 45500, Page 6 - "Hi-Fi techniques, requirements for amplifiers".

A scope sync (250 Hz) is available at a BNC connector on the rear panel.

The Passive, High-Pass Filter has been changed to have a cut-off frequency of 3.9 kHz.

The Low-Pass Filter has been changed to have a cut-off frequency of 1.25 kHz.

- b. The following parts have been changed:

Reference Designators	Description	Stock No.	Qty.
<u>IM Analyzer Board</u>			
C1, C2	.02 uf, 1%, 33V, plystr	2025-0004	2
C3, C4	.0068 uf, 2.5%, 63V, plystr	2025-0016	2
C32	.0082 uf, 1%, 33V, plystr	2025-0002	1
C37	.082 uf, 1%, 33V, plystr	2025-0005	1
C36	.0033 uf, 2.5%, 63V, plystr	2025-0014	1
C36A	680 pf, 2.5%, 63V, plystr	2025-0019	1
R46, 47, 48, 49	5.23 K, 1%, 1/8W, MF	1015-1523	4
<u>IM GENERATOR BOARD</u>			
C1, C2	.022 uf, 2.5%, 63V, plystr	2025-0029	2
R18, 20	10K, .25%, 1/8W, MF	1005-2100	2
R17	10K, 1%, 1/8W, MF	1015-2100	1
R16	52.3K, 1%, 1/8W, MF	1015-2523	1
R3, 5	28.7K, 1%, 1/8W, MF	1015-2287	2

- c. Also, the following changes or additions have been made:

1. Replace R4 (5K trim-pot) with a jumper.
2. Remove R2 (15K, 5%, 1/4W) from board.
3. Remove sync cable to IM generator Board (pad 7).
4. Add shielded cable between pad 5 on generator board and BNC scope sync connector on rear panel.

5-2. 50/60 Hz OPERATION (JAPAN)

The Low Frequency Oscillator is set to 60 Hz and is free-running. A scope sync is available at a BNC connector on the rear panel. Sections 5-1-C-2,3,4 above are applicable.

SECTION VII
SPARE PARTS

7-1. INTRODUCTION

This section contains information for ordering replacement parts, and provides the following details:

- a. Sound Technology part number.
- b. Circuit diagram reference designator.
- c. Description of part.
- d. Total quantities used.

7-2. ORDERING INFORMATION

When ordering replacement parts, each part must be identified by a Sound Technology part number. To order a part, include the following information:

- a. Instrument model number.
- b. Instrument serial number.
- c. Description of part.
- d. Function and location of part.

Address your order or inquiry to:

Sound Technology
1400 Dell Avenue
Campbell
California, 95008
(408) 378-6540

1700B DISTORTION ANALYZER

OPTION 004

PURCHASED PARTS

PART NO	DESCRIPTION	QTY	PART NO	DESCRIPTION	QTY
0300-0000	DIODE-LED RED CR24, 25	2.0	1015-1953	RES-FXD 9.53K 1% 1/8W R70, 72	2.0
1005-1787	RES-FXD 7.87K 0.25% 1/8W MF R32	1.0	1015-2100	RES-FXD 10K 1% 1/8W MF R1-5, 18, 19, 21, 50-53, 74	13.0
1005-2158	RES-FXD 15.8K 0.25% 1/8W MF R27	1.0	1015-2113	RES-FXD 11.3K 1% 1/8W MF R11	1.0
1400-0010	RES-VAR 5K 10% MOD. LOG. CARBON R31	1.0	1015-2130	RES-FXD 13.0K 1% 1/8W MF R46-49	4.0
1400-0011	RES-VAR 5K 10% LINEAR CARBON R38	1.0	1015-2133	RES-FXD 13.3K 1% 1/8W MF R15	1.0
1400-0012	RES-VAR 1K 10% CCW MOD. LOG. CAR R7	1.0	1015-2158	RES-FXD 15.8K 1% 1/8W MF R67	1.0
3005-0003	SWITCH-SLIDE DP3T MINIATURE S7	1.0	1015-2261	RES-FXD 26.1K 1% 1/8W MF R71	1.0
7900-0009	MANUAL-IMA OPTION	1.0	1015-2316	RES-FXD 31.6K 1% 1/8W MF R76	1.0
8000-0000	PUSHBUTTON-WHITE	6.0	1015-2365	RES-FXD 36.5K 1% 1/8W R73	1.0
8000-0006	KNOB-ROUND 1/2 OD, 1/8 ID BEIGE	3.0	1015-2374	RES-FXD 37.4K 1% 1/8W MF R68	1.0
8000-0011	KNOB-1/2 DIA. 1" SKIRT, BEIGE	1.0	1015-2392	RES-FXD 39.2K 1% 1/8W MF R13, 31, 32	3.0
01700-1029	SHIELD-IM ANALYZER	1.0	1015-2487	RES-FXD 48.7K 1% 1/8W MF R9	1.0
01700-1030	BRACKET-REAR IM	1.0	1100-0022	RES-FXD 22.5% 1/4W R62	1.0
01700-1032	TRIM PLATE-IMA	1.0	1100-0027	RES-FXD 27.5% 1/4W R41	1.0
01700-1033	SWITCH PLATE-IMA	1.0	1100-0091	RES-FXD 91.5% 1/4W R60, 61	2.0
01700-30017	ASSY-PC, IM ANALYZER	1.0	1100-0100	RES-FXD 100.5% 1/4W R54, 56, 57, 69	4.0
01700-30018	PC-ASSY IM SIGNAL GENERATOR	1.0	1100-0510	RES-FXD 510.5% 1/4W R45, 80	2.0
01700-30021	ATTEN SWITCH ASSEMBLY, IM OPT	1.0	1100-1100	RES-FXD 1K 5% 1/4W R40, 42, 58, 78, 79	5.0

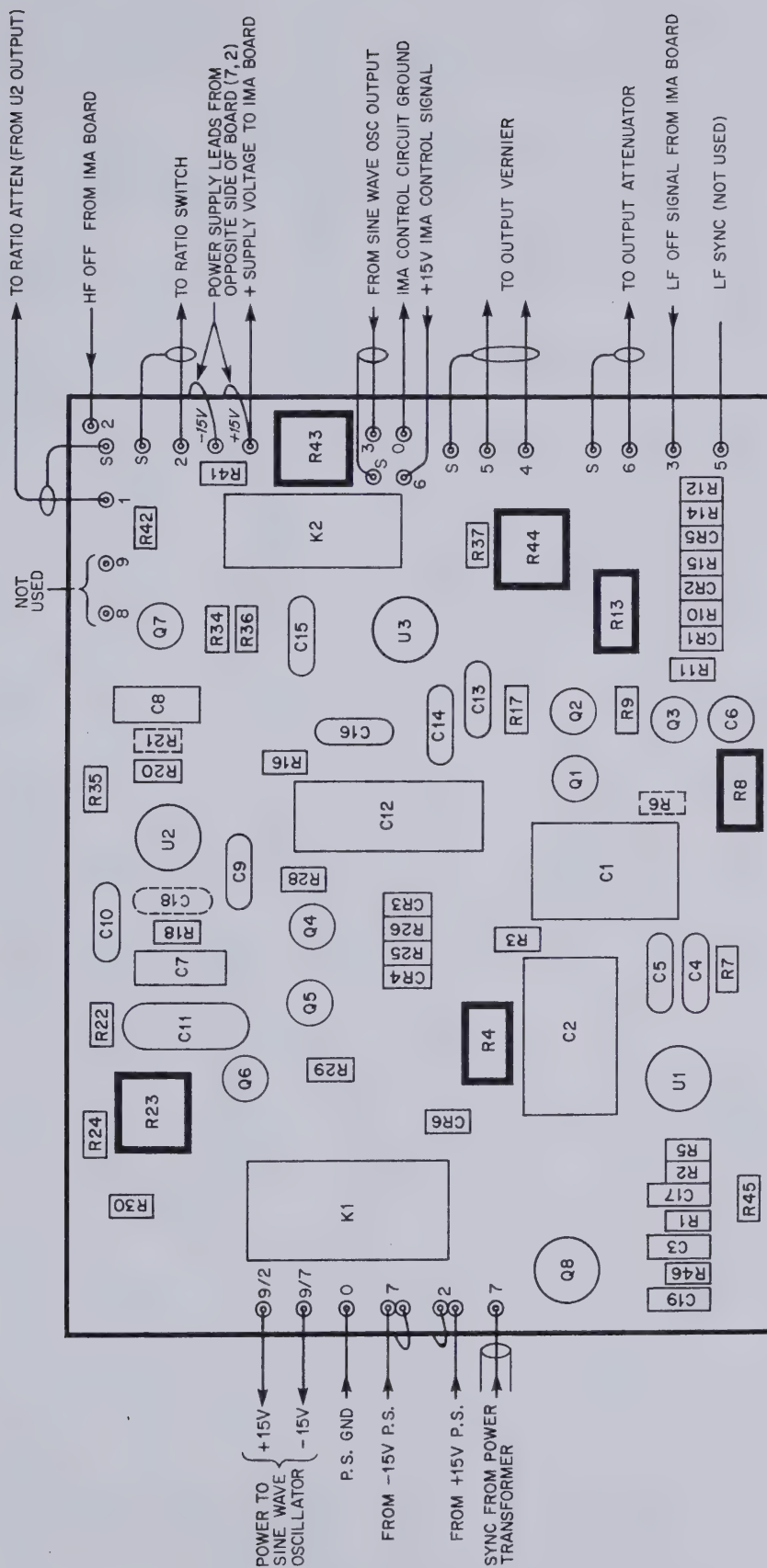
01700-30017 ASSY-PC,
IM ANALYZER

PART NO	DESCRIPTION	QTY	PART NO	DESCRIPTION	QTY
0005-0000	TRANS 2N3053 NPN SI Q1-4	4.0	1100-1330	RES-FXD 3.3K 5% 1/4W R39	1.0
0100-0001	IC-OP AMP 741 U2, 3, 4, 6, 7, 10, 11, 12	8.0	1100-2100	RES-FXD 10K 5% 1/4W R44	1.0
0100-0014	IC-OP AMP 2605 GRADE 6 BLUE U1, 9	2.0	1100-2330	RES-FXD 33K 5% 1/4W R43	1.0
0100-0016	OP-AMP 301C U5, 8, 13-17	7.0	1100-2470	RES-FXD 47K 5% 1/4W R37	1.0
0200-0000	DIODE-GEN 1N914A SI CR3-5, 7-22	19.0	1100-3100	RES-FXD 100K 5% 1/4W R26	1.0
0205-0002	DIODE-ZENER 1N750 4.7V CR6	1.0	1100-4100	RES-FXD 1M 5% 1/4W R55, 59	2.0
1015-0010	RES-FXD 10 1% 1/8W MF R33, 64, 65	3.0	1410-0001	RES-VAR 100 TRIMPOT CERMET R63	1.0
1015-0019	RES-FXD 19.6 1% 1/8W MF R8	1.0	1410-0002	RES-VAR 500 TRIMPOT CERMET R34	1.0
1015-0182	RES-FXD 182 1% 1/8W MF R66	1.0	1410-0004	RES-VAR 5K TRIMPOT CERMET R22	1.0
1015-1100	RES-FXD 1K 1% 1/8W MF R6, 23, 35, 36, 77	5.0	2000-0005	CAP-FXD 5PF 10% 500V MICA C43	1.0
1015-1187	RES-FXD 1.87K 1% 1/8W MF R12	1.0	2000-0007	CAP-FXD 7PF 5% 500V MICA C69	1.0
1015-1200	RES-FXD 2K 1% 1/8W MF R29, 30	2.0	2000-0010	CAP-FXD 10PF 5% 500V MICA C28	1.0
1015-1232	RES-FXD 2.32K 1% 1/8W MF R38	1.0	2000-0056	CAP-FXD 56PF 5% 500V MICA C7, 51	2.0
1015-1301	RES-FXD 3.01K 1% 1/8W R75	1.0	2000-0150	CAP-FXD 150PF 5% 500V MICA C27, 50	2.0
1015-1422	RES-FXD 4.22K 1% 1/8W MF R24	1.0	2000-0470	CAP-FXD 470PF 5% 500V MICA C47	1.0
1015-1499	RES-FXD 4.99K 1% 1/8W MF R20	1.0	2020-0002	CAP-FXD 0.056UF 10% 100V MYLAR C66	1.0
1015-1523	RES-FXD 5.23K 1% 1/8W MF R14	1.0	2025-0002	CAP-FXD 0.0002UF 1% 33V PLYSTR C8-10	3.0
1015-1681	RES-FXD 6.81K 1% 1/8W MF R10	1.0	2025-0003	CAP-FXD 0.01UF 1% 33V PLYSTR C13, 14, 17, 18, 36	5.0
1015-1715	RES-FXD 7.15K 1% 1/8W MF R27, 28	2.0			

PART NO	DESCRIPTION	QTY	PART NO	DESCRIPTION	QTY
2025-0004	CAP-FXD 0.02UF 1% 33V PLYSTR C3, 4, 32	3.0	1015-1392	RES-FXD 3.92K 1% 1/8W MF R7, 22	2.0
2025-0007	CAP-FXD 0.2UF 1% 100V FILM C37	1.0	1015-1464	RES-FXD 4.64K 1% 1/8W MF R10, 12, 25, 26	4.0
2025-0010	CAP-FXD .039UF 2.5% 33V PLYSTR C57	1.0	1015-1576	RES-FXD 5.76K 1% 1/8W MF R41	1.0
2025-0015	CAP-FXD .015UF 2.5% 63V PLYSTR C56	1.0	1015-1681	RES-FXD 6.81K 1% 1/8W MF R14, 28	2.0
2025-0017	CAP-FXD .056UF 2.5% 33V PLYSTR C1, 2	2.0	1015-2100	RES-FXD 10K 1% 1/8W MF R16	1.0
2025-0029	CAP-FXD .022UF 2.5% 63V PLYSTR C60	1.0	1015-2249	RES-FXD 24.9K 1% 1/8W MF R3	1.0
2025-0030	CAP-FXD .027UF 2.5% 63V PLYSTR C61	1.0	1015-2274	RES-FXD 27.4K 1% 1/8W MF R5	1.0
2040-0000	CAP-FXD 0.01UF 100V CERAMIC C5, 6, 11, 12, 15, 16, 19, 20, 25, 26, 30, 31, 38-41, 48, 49, 58, 59, 62-65	24.0	1100-0510	RES-FXD 510 5% 1/4W R36	1.0
2040-0002	CAP-FXD 0.1UF 25V CERAMIC C70, 71	2.0	1100-1100	RES-FXD 1K 5% 1/4W R6	1.0
2100-0000	CAP-FXD 4.7UF 10% 35V TANT C78	1.0	1100-1180	RES-FXD 1.8K 5% 1/4W R45	1.0
2100-0001	CAP-FXD 1UF 25V ELECT AL C35	1.0	1100-1330	RES-FXD 3.3K 5% 1/4W R34	1.0
2100-0003	CAP-FXD 10UF 25V ELECT AL C21, 22, 74	3.0	1100-1910	RES-FXD 9.1K 5% 1/4W R35	1.0
2100-0004	CAP-FXD 35UF 25V ELECT AL C53, 54, 72, 73	4.0	1100-2150	RES-FXD 15K 5% 1/4W R1, 2	2.0
2100-0005	CAP-FXD 50UF 25V ELECT AL C34, 77	2.0	1100-2180	RES-FXD 18K 5% 1/4W R46	1.0
2100-0006	CAP-FXD 100UF 25V ELECT AL C45, 46, 52, 75, 76	5.0	1100-2330	RES-FXD 33K 5% 1/4W R11	1.0
2100-0019	CAP-FXD 800UF 6V ELECT C55	1.0	1100-2390	RES-FXD 39K 5% 1/4W R29	1.0
3015-0007	SWITCH-PB, 4 STA 6P & 2 STA P-P S1-6	1.0	1100-2560	RES-FXD 56K 5% 1/4W R15	1.0
3105-0000	SOCKET-IC 8 PIN ROUND	17.0	1100-2750	RES-FXD 75K 5% 1/4W R30	1.0
3120-0000	CONN-SINGLE CONTACT, .093 PIN	21.0	1410-0002	RES-VAR 500 TRIMPOT CERMET R23	1.0
3120-5000	CONN-SINGLE CONTACT, .093 SOCKET	21.0	1410-0003	RES-VAR 1K TRIMPOT CERMET R43, 44	2.0
3150-0002	SPACER-PUSHBUTTON SW, DOGBONE	6.0	1410-0008	RES-VAR 1K TRIMPOT, STANDUP R8	1.0
3400-0002	RELAY-1 FORM A K2	1.0	1410-0009	RES-VAR 500 TRIMPOT, STANDUP R13	1.0
3400-0003	RELAY-2 FORM A K1	1.0	1410-0010	RES-VAR 5K TRIMPOT, STANDUP R4	1.0
8000-0000	PUSHBUTTON-WHITE	6.0	2000-0010	CAP-FXD 10PF 5% 500V MICA C13	1.0
01700-5017	PC BOARD-IM ANALYZER	1.0	2000-0056	CAP-FXD 56PF 5% 500V MICA C16	1.0
01700-30018 PC-ASSY IM SIGNAL GENERATOR			2020-0013	CAP-FXD 0.033UF 10% 100V MYLAR C11	1.0
PART NO	DESCRIPTION	QTY	2025-0001	CAP-FXD 0.002UF 1% 33V PLYSTR C7, 8	2.0
0000-0001	TRANS 2N3644 PNP SI 01, 2, 4, 5, 7	5.0	2025-0006	CAP-FXD 0.1UF 1% 33V PLYSTR C1, 2	2.0
0005-0000	TRANS 2N3053 NPN SI 08	1.0	2040-0000	CAP-FXD 0.01UF 100V CERAMIC C4, 5, 9, 10, 14, 15	6.0
0020-0001	TRANS-FET VCR3P P-CHAN 03, 6	2.0	2100-0000	CAP-FXD 4.7UF 10% 35V TANT C6	1.0
0100-0001	IC-OP AMP 741 U1	1.0	2100-0006	CAP-FXD 100UF 25V ELECT AL C12	1.0
0100-0007	IC-OP AMP 2605 GRADE 2 RED U3	1.0	2100-0020	CAP-FXD 1UF 50V ELECT TANT AXL C3, 17, 19	3.0
0100-0014	IC-OP AMP 2605 GRADE 6 BLUE U2	1.0	3105-0000	SOCKET-IC 8 PIN ROUND	3.0
0200-0000	DIODE-GEN 1N914A SJ CR1-6	6.0	3400-0001	RELAY-1 FORM C K2	1.0
1005-2114	RES-FXD 11.4K 0.25% 1/8W MF R18, 20	2.0	3400-0003	RELAY-2 FORM A K1	1.0
1005-2158	RES-FXD 15.8K 0.25% 1/8W MF R33, 42	2.0	8540-0004	SCREW 6-32 X 1/4 POZI PAN HD	2.0
1015-1100	RES-FXD 1K 1% 1/8W MF R17, 37	2.0	8542-0001	LOCKWASHER-EXT #6	2.0
1015-1150	RES-FXD 1.5K 1% 1/8W MF R9, 24	2.0	8702-0002	SPACER-THD, 6-32 3/8LG X 5/16OD	2.0
			01700-5018	PC BOARD-IM OSCILLATOR	1.0

01700-30021 ATTEN SWITCH
ASSEMBLY

PART NO	DESCRIPTION	QTY
1000-0005	RES-FXD 600.0 .1% 1/10 T2 R48	1.0
1000-0006	RES-FXD 660.0 .1% 1/10 T2 R54	1.0
1000-0007	RES-FXD 733.3 .1% 1/10 T2 R52	1.0
1000-0008	RES-FXD 741.6 .1% 1/10 T2 R50	1.0
1000-0009	RES-FXD 877.5 .1% 1/10 T2 R56	1.0
1000-0010	RES-FXD 1.297K 0.1% 1/10W MF R55	1.0
1000-0011	RES-FXD 5.940K 0.1% 1/10W MF R51, 53	2.0
1000-0012	RES-FXD 6.000K 0.1% 1/10W MF R49	1.0
3010-0005	SWITCH-ROTARY JM ATTEN S2	1.0

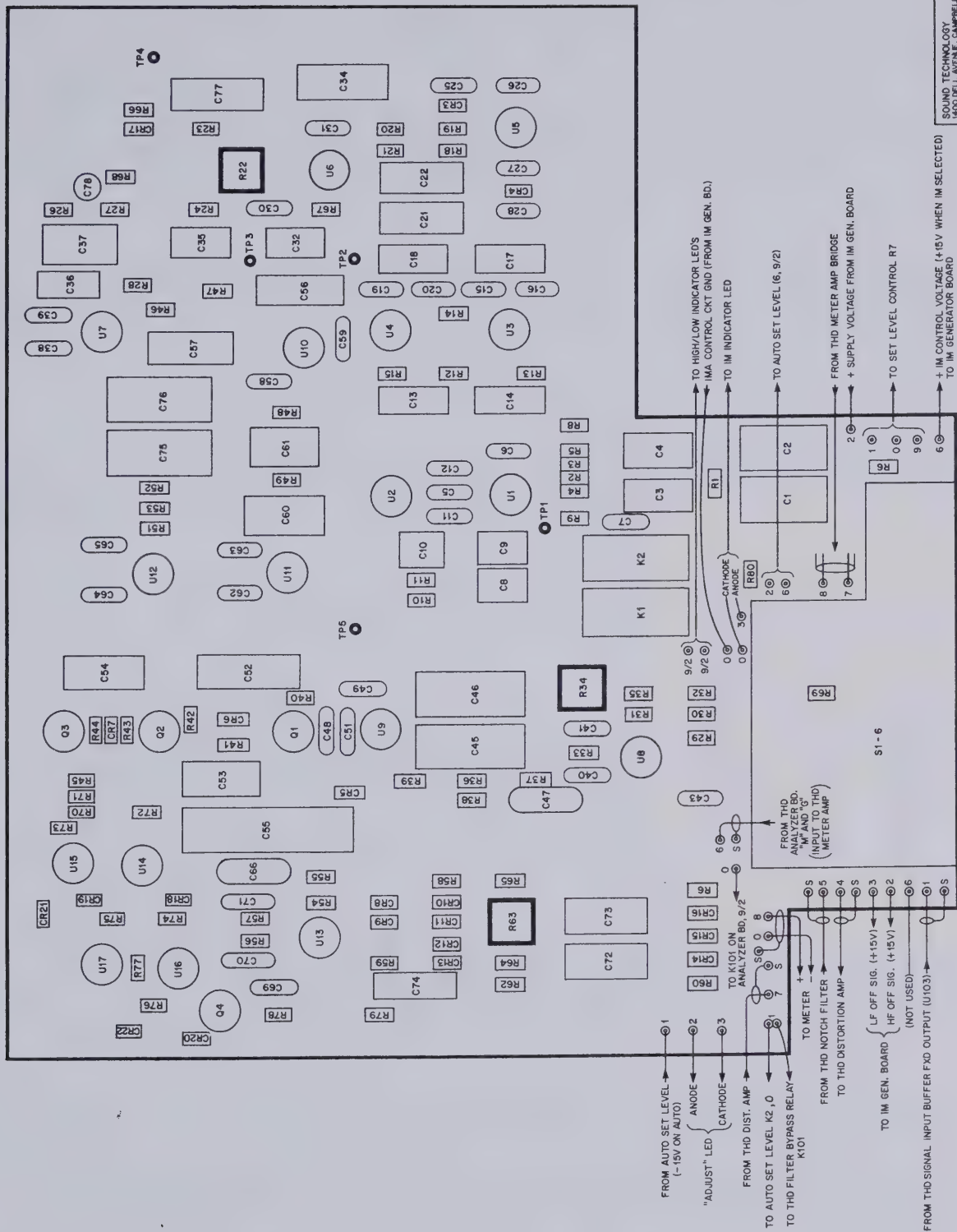


6-1

SOUND TECHNOLOGY
1400 DELL AVENUE, CAMPBELL, CALIFORNIA

IM GENERATOR BOARD

4/76



ACTUALLY
THIS
PERTAINS
TO THE
1700A

!

SECTION I OPERATION

1-1. SCOPE OF SECTION

The section contains information and instructions necessary for the operation of the Sound Technology Model 1700A Distortion Measurement System. Included are power requirements, cabling information and operating instructions.

1-2. INTRODUCTION

The Model 1700A Distortion Measurement System combines an ultra-low distortion oscillator, a high-resolution automatic-measuring distortion analyzer, and an accurate ac voltage/power meter in one instrument. Pushbutton operation permits the operator to quickly measure voltage or power, set level, and then measure distortion.

The oscillator section provides a pure sine wave signal for testing from 10 Hz to 110 kHz. Amplitude is variable from 3 volts to less than 1 mV.

The analyzer section contains a tracking notch filter which is always tuned to the oscillator frequency. The analyzer measures total harmonic distortion with a sensitivity ranging from 100% to .01% full scale, with automatic nulling on all ranges. Active filters may be selected for low frequency and high frequency noise suppression, enhancing the measurement resolution. A differential front end rejects common-mode noise.

The ac voltage/power meter inherent in the analyzer measures ac voltage, or power across an 8-ohm external load. The measurement range for ac voltage is 3 mV to 300 V full scale (30 μ V to 1 mV in Extended Range Para. 1-16) and for power is 1 μ W to 10 kW full scale. Voltage ratio measurements with a 100 dB or more of dynamic range can also be made.

1-3. INPUT POWER REQUIREMENTS

The Model 1700A System may be operated from either a 95-125 volt or 200-250 volt, 50 to 60 Hz power source. A two-position selector switch on the rear panel selects the power source. Before connecting the instrument to the power outlet, check that the selector switch setting matches the nominal line voltage of the source.



The Model 1700A System is protected from ac power overloads by a fuse (1A, fast-blown) located in a cartridge-type fuse holder on the rear panel.

1-4. POWER CABLE

The International Electrotechnical Commission (IEC) recommends that instrument panels and cabinets be grounded to protect operating and servicing personnel. The Model 1700A system is equipped with a three-conductor power cable assembly which, when plugged into the appropriate outlet, grounds the unit through the round offset pin.

1-5. CONTROLS AND INDICATORS

The data sheet at the front of the manual illustrates and describes briefly the Model 1700A Distortion Measurement System's front panel controls and indicators. The following provides additional explanatory information:

- a. POWER ON switch connects ac power to Model 1700A System. Pilot lamp glows when instrument is turned ON.
- b. +INPUT and -INPUT terminals -- Provide connections for signal being measured.
- c. GND () terminal -- Provides connection to chassis ground.
- d. COM () terminal -- Provides connection to circuit common.
- e. VOLTS/POWER pushbutton -- Selects Volts or Power measurement function.

- f. INPUT switch -- Selects full scale meter range for Volts or Power measurement function. Readings are in volts rms or watts.
- g. OVERLOAD indicator -- Indicator is lit when input signal overloads input buffer. This warns operator that Volts or Power measurement is no longer accurate.
- h. SET LEVEL pushbutton -- Selects Set Level function whereby meter displays reference signal level for Distortion or Ratio measurement.
- i. SET LEVEL ADJUST -- Adjusts reference signal level for Distortion or Ratio measurement. When control is set to CAL position (max. counterclockwise), RATIO ranges extend voltage measurement capability to 30 μ V full scale (Paragraph 1-16).
- j. DISTORTION pushbutton -- Selects Distortion measurement function.
- k. dB VOLTS pushbutton -- Selects Ratio measurement function.
- l. RATIO Switch -- Selects full scale meter range for Distortion and Ratio measurement functions. Readings are in percent or dB.
- m. NOTCH FREQUENCY indicators -- Facilitate tuning when using an external oscillator. When LOW indicator is lit, Model 1700A System frequency is low with respect to incoming signal, when HIGH indicator is lit, Model 1700A System frequency is high with respect to incoming signal. System is correctly tuned when both indicators are extinguished. (It is normal for one of these indicators to glow when there is no input to the 1700A.)
- n. SIGNAL COMMON switch -- Switches circuit common from chassis ground, breaking ground loops. FLOAT position floats (disconnects) circuit common of System from chassis ground; Chassis Ground (⏏) position connects circuit common of System to chassis ground.
- o. FILTERS -- 400 Hz pushbutton selects a filter which suppresses low-frequency noise (such as 60 Hz hum) below 400 Hz. 80 kHz pushbutton selects a filter which suppresses high-frequency noise above 80 kHz. The 80 kHz filter also reduces effects of AM radio station pickup. Both filters affect meter reading only on Distortion and Ratio measurement functions. They do not affect meter reading on Volts/Power, and Set Level measurement functions. The 400 Hz filter is usable with fundamental frequencies down to 400 Hz when making distortion measurements.
- p. METER -- Indicates signal level of measurement selected by Function pushbutton.
- q. DISTORTION OUTPUT BNC connector -- Provides distortion product of signal being analyzed (suitable for viewing on oscilloscope) on Volts/Power, Set Level, and Distortion measurement functions. On Ratio measurement function, this output provides a scaled version of input signal. Output is 31.6 mV full scale.
- r. FAST RESPONSE/LOW DISTORTION switch -- Selects operating mode of oscillator. FAST RESPONSE causes oscillator amplitude to settle quickly after a frequency change. This mode is recommended when ultra-low distortion measurements are not required, for example when making frequency response measurements. LOW DISTORTION selects full ultra-low distortion capability of oscillator. The settling time in this mode is less than 5 seconds. Actuation of FREQUENCY pushbuttons generally causes oscillator to go first to FAST RESPONSE mode and then to settle in LOW DISTORTION mode. This switch controls only the oscillator and is not connected to the distortion analyzer.
- s. FAST RESPONSE indicator -- Indicates operating mode of oscillator. When lit, oscillator is in Fast Response mode and does not have ultra-low distortion.
- t. FREQUENCY pushbuttons -- Simultaneously select oscillator and distortion analyzer frequency. Four Multiplier switches and 30 Digit switches permit 3-digit resolution within each range. Frequency range of Model 1700A System is 10 Hz to 109.9 kHz. One button in each row must be depressed at all times.

- u. OSCILLATOR LEVEL control -- Adjusts amplitude of oscillator. Level is variable from 3 volts to below 1 millivolt. Control is single-turn logarithmic potentiometer.
- v. SIGNAL OUTPUT BNC connector -- Provides oscillator output signal. Output impedance varies with setting of OSCILLATOR LEVEL control and reaches a maximum of 625 ohms at mid-range.
- w. BUFFERED INPUT SIGNAL BNC connector (located on rear panel) -- Provides replica of input signal being analyzed. This signal is referenced to ground and intended to be connected to an oscilloscope.

1-6. TEST SETUP

In order to take full advantage of the unique ultra-low distortion measuring capabilities of the Model 1700A System it is extremely important that the cabling between the Model 1700A, the amplifier under test, and other test equipment be connected in compliance with the arrangement shown in Figure 1-1 and described in the following paragraphs. The connections and controls numbered in Figure 1-1 are similarly identified in the test. These connections have been found to provide the optimum test setup in most cases.

1-7. POWER CONNECTIONS

- a. Check that power slide switch on rear panel of Model 1700A is set to correct position for available ac power (see Paragraph 1-3 for details).
- b. Do not float the earth ground lead of the power cord of the Model 1700A. (The differential input makes this step unnecessary for breaking ground loops.)
- c. Plug the Model 1700A, amplifier under test and the oscilloscope (if used) closely to each other into the ac power bus.

1-8. GROUND CONNECTIONS

- a. Connect Model 1700A GND (⚡) terminal (1) to ground terminal (chassis ground) of amplifier under test.

NOTE

This reduces common mode 60-Hz potential differences and provides a path to ground for 60-Hz current that may be injected into the chassis of the amplifier under test from its own primary power circuits.

- b. Connect oscilloscope (if used) to BUFFERED INPUT SIGNAL BNC connector (2) on rear panel of Model 1700A via cable (3).

NOTE

1. This output is from the differential to single-ended converter in the Model 1700A which provides a replica of the input signal. This signal is referenced to ground.

2. If a BNC cable is not used for this connection, the oscilloscope common (low) terminal must be returned to the Model 1700A System GND (⚡) terminal (1) via a direct connection (4).

- c. This completes the ground connections necessary for proper Model 1700A operation.

1-9. SIGNAL CONNECTIONS

CAUTION

CONNECTING OSCILLATOR OUTPUT TO A HOT CHASSIS MAY BLOW FUSE, F2 or F3.
(Fuses located on bottom of instrument. A blown fuse will make FLOAT switch ineffective and cause hum problems.)

DO NOT EXCEED THE INPUT VOLTAGES LISTED BELOW TO PREVENT BLOWING F101 AND F102.

With Input Range Switch -- 3 V and Lower.

- 1. 300V Below 60 Hz
- 2. 50 V Above 1 kHz

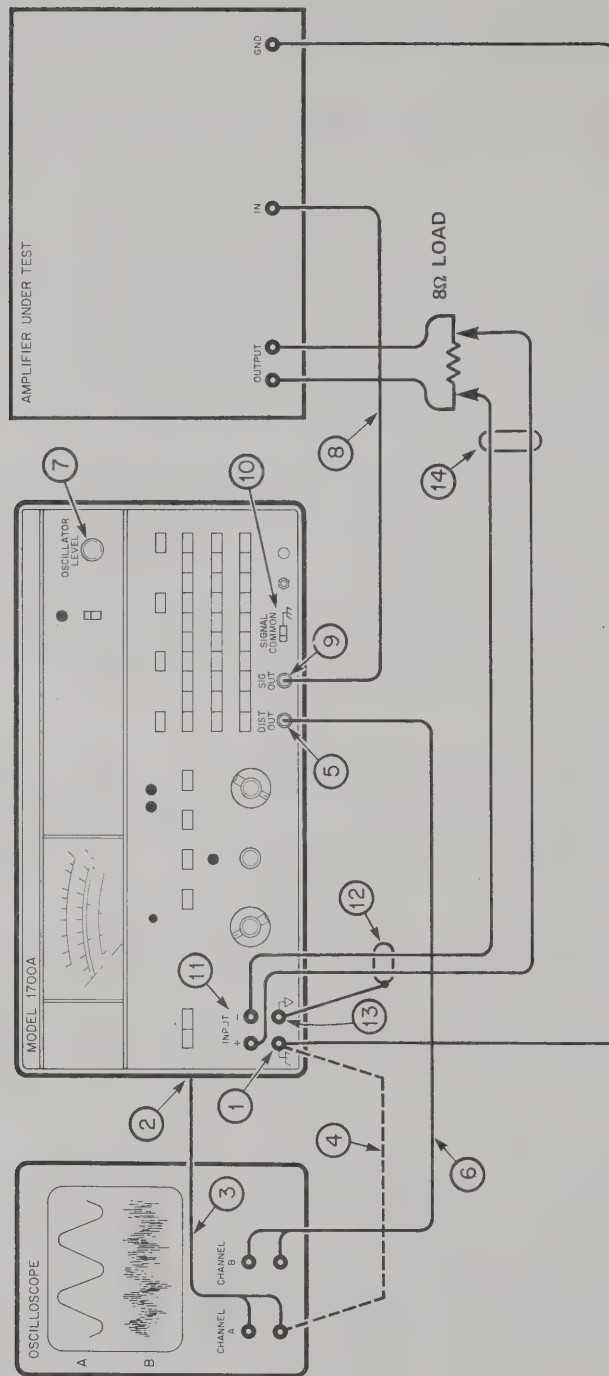


Figure 1-1 Model 1700A Test Setup

- a. Connect oscilloscope (if used) to DISTORTION OUTPUT connector (5) via cable (6). This permits monitoring the distortion products of the signal being analyzed.


NOTE

The shell of the DISTORTION OUTPUT BNC connector is returned inside the Model 1700A System to circuit common through a 1 μ F capacitor. The shell of the rear-panel BNC connector is at chassis ground. The above connections place this 1 μ F between the Model 1700A System circuit common and the chassis when using an oscilloscope. This permits reasonably noise-free viewing of the waveforms while still retaining a considerable amount of immunity to ground loop currents flowing between the Model 1700A SIGNAL OUTPUT and the input of the amplifier under test.

- b. Turn OSCILLATOR LEVEL control (7) fully counterclockwise (minimum level).
- c. Set gain control on amplifier under test to its lowest setting.
- d. Connect cable (8) between SIGNAL OUTPUT BNC connector (9) and input of amplifier under test.
- e. Set SIGNAL COMMON switch (10) to FLOAT.

NOTE

This achieves the ultimate rejection of unwanted power-line related noise (especially in the leads of the input of the amplifier under test). With no other equipment such as an oscilloscope connected to the system, there is only a nominal .001 μ F of capacitance between the System circuit common and chassis ground. The corresponding reactance, greater than 2 megohms at 60 Hz, effectively opens the ground loops between the Model 1700A and the amplifier under test.

- f. Connect output of amplifier under test to a suitable 8 ohm load resistor. (Load resistor should be in a location free from any ac magnetic field, such as caused by a power transformer, to avoid hum pickup).
- g. Connect signal to be measured (voltage developed across 8 ohm load) between +INPUT and -INPUT terminals (11). Use shielded twisted-pair cable for this connection and keep test leads as short as possible to avoid extraneous pick up from stray ac fields.
- h. Connect shield (12) of input wiring to COM () terminal (13). Leave shield (14) at other end unconnected.

NOTE

1. The input terminals do not have a polarity (as indicated) for ac and may be connected either way with no damage to the amplifier under test.

2. Each INPUT terminal has its own input attenuator and buffer amplifier. Input impedance is 100 kilohm from each terminal to the Model 1700A System circuit common. The true differential input circuits of the Model 1700A System help break the ground loop that causes 60-Hz pickup on the input leads of most measuring equipment.

3. Do not connect one channel of the oscilloscope directly to the output of the amplifier under test as this can upset the noise rejection capability of the Model 1700A System differential input circuitry. If it is absolutely essential to monitor this signal, leave the ground lead of the scope channel disconnected from the amplifier under test.

1-10. OPERATING PROCEDURES

CAUTION

CONNECTING OSCILLATOR OUTPUT TO A HOT CHASSIS MAY BLOW FUSE, F2 or F3.
(Fuses located on bottom of instrument. A blown fuse will make FLOAT switch ineffective and cause hum problems.)

DO NOT EXCEED THE INPUT VOLTAGES BELOW TO PREVENT BLOWING FUSES F101 AND F102.

With Input Range Switch -- 3V and Lower

1. 300 V Below 60 Hz
2. 50 V Above 1 kHz

1-11. TEST CONNECTIONS

Before making measurements with the Model 1700A System, ensure that the equipment has been connected as shown in Figure 1-1 and following the instructions given in Paragraphs 1-6 through 1-9.

1-12. METER MECHANICAL ZERO ADJUSTMENT

The meter is correctly zero set when the pointer rests over the zero calibration marks on the scale when the Model 1700A INPUT switch is set to 300 V, the VOLTS POWER pushbutton is depressed, and there is no input signal (input leads disconnected). To adjust the zero set proceed as follows:

- a. Rotate zero adjustment screw (located on front panel below meter) until pointer is left of zero. Reverse rotation until pointer is exactly at zero.

1-13. DISTORTION MEASUREMENT

To measure the total harmonic distortion of a signal, proceed as follows:

- a. Set FAST RESPONSE/LOW DISTORTION switch to LOW DISTORTION and select fundamental test frequency in Hz by depressing appropriate FREQUENCY pushbuttons.

NOTE

1. Four Multiplier pushbuttons (X1, X10, X100, X1000) and 30 Digit pushbuttons permit 3-digit resolution of frequency selection. For example, 453 Hz would be selected by depressing the following pushbuttons:

<u>Multiplier</u>	<u>1st. Digit</u>	<u>2nd. Digit</u>	<u>3rd. Digit</u>	<u>Frequency</u>
X10	40			$40 \times 10 = 400$
		5		$5 \times 10 = 50$
			.3	$.3 \times 10 = 3$
				<u>453 Hz</u>

The "100" Digit pushbutton provides a 10% overlap in range. For example, 1010 Hz can be selected in two ways:

<u>Multiplier</u>	<u>1st. Digit</u>	<u>2nd. Digit</u>	<u>3rd. Digit</u>	<u>Frequency</u>
X10	100			$100 \times 10 = 1000$
		1		$1 \times 10 = 10$
			0	$0 \times 10 = 0$
				<u>1010 Hz</u>
X100	10			$10 \times 100 = 1000$
		0		$0 \times 100 = 0$
			.1	$.1 \times 100 = 10$
				<u>1010 Hz</u>

2. In the X1 range, operation of the frequency pushbuttons may not always cause the oscillator to go through its automatic stabilization cycle. If the oscillator amplitude appears to be unstable, momentarily set the FAST RESPONSE/LOW DISTORTION switch to the FAST RESPONSE position and then return it immediately to the LOW DISTORTION setting.

- b. Depress VOLTS POWER pushbutton and set ADJUST control fully CCW to CAL position.
- c. Set INPUT switch to expected range setting.
- d. Adjust OSCILLATOR LEVEL control and/or gain control on amplifier under test for desired voltage/power level as indicated on Model 1700A meter. Up range INPUT switch when meter pointer passes full scale and down range when meter pointer goes below 1/3 of full scale.

NOTE

If OVERLOAD indicator lights and meter reads less than full scale, meter reading is incorrect due to ADJUST control being incorrectly set. To regain accuracy, turn ADJUST control down (CCW) until OVERLOAD light is OFF.

- e. Depress SET LEVEL pushbutton and rotate set level ADJUST control until meter pointer rests on SET LEVEL mark.
- f. Depress DISTORTION pushbutton and rotate RATIO switch until meter pointer reaches upper 2/3's of scale. If desired, depress 400 Hz and/or 80 kHz FILTER pushbutton to filter noise from input signal.
- g. Observe distortion either in percentage or dB, as indicated by meter deflection and RATIO switch setting. For example, if meter reads .67 and RATIO setting is .1%, distortion measured is .067%.

1-14. DISTORTION MEASUREMENT WITH EXTERNAL OSCILLATOR

- a. Connect equipment as shown in Figure 1-1, with the following exceptions:
 - 1. Connect power cord of external oscillator to power source close to source used by Model 1700A, amplifier under test, and oscilloscope.
 - 2. Connect output of oscillator to input of amplifier under test. The oscillator output may be floated if this gives better test results.
 - 3. Connect chassis of oscillator to GND (⏏) terminal on Model 1700A.
 - 4. Set SIGNAL COMMON switch on Model 1700A to ⏏ (ground) position.
- b. Set external oscillator to desired frequency and signal level.
- c. Preset Model 1700A FREQUENCY pushbuttons to approximate frequency of external oscillator.
- d. Set ADJUST control fully counterclockwise (CCW) to CAL position and depress VOLTS POWER pushbutton.
- e. Set INPUT switch to expected range.
- f. Adjust external oscillator amplitude control and/or gain control of amplifier under test for desired voltage/power level as indicated on Model 1700A meter.
- g. Depress SET LEVEL pushbutton. Rotate ADJUST control until Meter pointer rests on SET LEVEL mark.
- h. Set 1700A frequency or external oscillator frequency so both NOTCH FREQUENCY indicators are off and that the tuning is approximately centered.
- i. Depress DISTORTION pushbutton and set RATIO switch so that meter pointer rests within upper 2/3's of scale. If desired, depress 400 Hz and/or 80 kHz pushbutton to filter noise from input signal.
- j. Observe distortion in either percentage or dB, as indicated by meter deflection and RATIO range setting.

1-15. AC VOLTAGE/POWER MEASUREMENT

The Model 1700A is an accurate ac voltage/power meter over its entire frequency range. The power scale is calibrated for an 8-ohm load, which must be provided externally. Voltage may be measured directly from 3 mV to 300 V full scale and power from 1 μ V to 10 kW full scale. To measure ac voltage or power, proceed as follows:

- a. Ensure that the power and ground connections are as described in Paragraphs 1-7 and 1-8 respectively.

- b. Connect signal to be measured between + INPUT and - INPUT terminals. Use shielded twisted-pair cable for low-level inputs. Connect shield to COM (∇) terminal.
- c. Set ADJUST control to CAL position and depress VOLTS POWER pushbutton.
- d. Rotate INPUT switch for an on scale reading (pointer in upper 2/3's of scale).

NOTE

The 400 Hz and 80 kHz FILTERS do not affect readings on the ac Voltage Power measurement function.

1-16. AC VOLTAGE MEASUREMENT - EXTENDED RANGE

The sensitivity of the ac voltmeter can be extended to 30 μ V full scale through the use of the RATIO switch. To obtain this increased sensitivity carry out the following steps:

- a. Ensure that power and ground connections are as described in Paragraphs 1-7 and 1-8 respectively.
- b. Connect signal to be measured between + INPUT and - INPUT terminals. Use shielded twisted-pair cable for signal connection. Connect shield to COM (∇) terminal.
- c. Set Model 1700A controls as follows:
 dB VOLTS switch ----- depressed
 INPUT switch ----- .3 V
 ADJUST control ----- CAL
- d. Meter full scale sensitivity is now controlled by RATIO switch as follows:

<u>RATIO switch</u>	<u>Full Scale Sensitivity</u>
-80 dB	30 μ V
-70 dB	100 μ V
-60 dB	300 μ V
-50 dB	1 mV

NOTE

The 400 Hz and 80 kHz FILTERS will affect meter readings in this mode of operation.

1-17. dB VOLTS MEASUREMENTS

The dB Volts function facilitates the measurement of voltage ratio, signal-to-noise ratio, and frequency response, in dB or percent. The signal-to-noise ratio measurement described below provides an example of the use of this function.

- a. Ensure that power and ground connections are as described in Paragraphs 1-7 and 1-8 respectively.
- b. Set ADJUST control to CAL position and depress VOLTS POWER pushbutton.
- c. Set INPUT switch to expected range and adjust appropriate signal level controls for desired output signal, as indicated on meter.
- d. Depress SET LEVEL pushbutton and rotate ADJUST control until meter pointer rests on 0 dB mark.

NOTE

For proper 0 dB or 100% set level, reference signal must be at least .1 V and not exceed 300 V.

- e. Remove input signal to amplifier under test and replace with a short circuit across amplifier's input terminals. Set SIGNAL COMMON switch to ∇ (ground) position.

NOTE

When the input signal to the amplifier under test is removed and replaced with a short, this floats entire Model 1700A measuring circuits. Proper grounding can be restored by setting the CIRCUIT COMMON switch to the \perp (ground) position.

- f. Depress dB VOLTS pushbutton. Select RATIO switch range which places meter pointer in upper 2/3's of scale, Read test result in dB.
- g. At end of signal-to-noise ratio measurement, return SIGNAL COMMON switch to FLOAT position.

1-18. AUDIO MEASUREMENTS

Operating instructions for performing certain audio measurements as specified by the Institute of High Fidelity (1960) are given below. For these tests, ensure that the following test conditions are maintained:

- a. Line: 120 V \pm 1%, 60 Hz, less than 2% total harmonic distortion.
- b. Temperature: 25 \pm 3° C.
- c. Preconditioning: Unit under test should be preconditioned for 1 hour at 1/10 rated power. (FTC requires 1/3 rated power).
- d. Amplifier Gain Controls: Set to maximum.
- e. Amplifier Tone Controls: Flat.
- f. Amplifier Balance Control: Set to normal.
- g. Test Equipment: Model 1700A exceeds all IHF requirements for test equipment accuracy.

1-19. MAXIMUM POWER OUTPUT AT RATED TOTAL HARMONIC DISTORTION AT 1 kHz

NOTE

Amplifier must be able to maintain this power for 30 seconds.

- a. Set Model 1700A for frequency output 1 kHz.
- b. Connect SIGNAL OUTPUT to amplifier's AUX or TAPE INPUT on all channels.
- c. Set RATIO SWITCH so that amplifier's rated distortion gives maximum on-scale reading, and observe distortion products on oscilloscope.
- d. Increase OSCILLATOR LEVEL setting until distortion products on oscilloscope are excessive while (1) monitoring power with VOLTS POWER pushbutton depressed and (2) keeping signal on scale with INPUT switch.
- e. When excessive distortion products are present, refine measurement by adjusting OSCILLATOR OUTPUT while measuring distortion until the amplifier's rated distortion is reached.
- f. Switch Model 1700A to VOLTS POWER function and determine amplifier's power output at rated distortion.

1-20. POWER BANDWIDTH

- a. Maintain test setup as described in Paragraph 1-19.
- b. Adjust amplifier level until power is 3 dB below rated power (1/2 power) at midband (full rated power for FTC).
- c. Increase Model 1700A frequency in steps from midband while measuring distortion. Stop when distortion is equal to amplifier's specifications. This is upper power bandwidth point.

- d. Repeat step c, this time decreasing Model 1700A frequency until lower power bandwidth point is found. The result may be expressed briefly (for example: Power Bandwidth = 15 Hz to 37 kHz); or it may be shown as a graph of distortion versus frequency, with power held constant at 3 dB below rated power.

1-21. HUM and NOISE or SIGNAL-to-NOISE RATIO

Make this measurement following the instructions given in Paragraph 1-17 for measuring voltage ratios. Drive the amplifier to its rated power output with gain controls set to maximum. Then remove the input and obtain a dB ratio reading as described in 1-17.

SECTION II PRINCIPLES OF OPERATION

2-1. INTRODUCTION

The Model 1700A Distortion Measurement System consists of an ultra-low distortion oscillator, a total harmonic distortion analyzer, and a dc power supply. The system makes total harmonic distortion measurements by applying a sine-wave of ultra-low distortion from the oscillator to the input of the amplifier under test while the distortion analyzer measures the amplifier output. A tunable notch filter in the analyzer, mechanically ganged to the oscillator by the front panel frequency select switches, suppresses the fundamental signal. Automatic nulling circuitry fine tunes the notch filter and ensures that the null is retained. The signal remaining at the output of the notch filter consists of the distortion products and noise. This is displayed by an average-reading voltmeter in the analyzer. The ratio of the measured distortion components to a previously set fundamental signal reference level is defined as the total harmonic distortion and can be read out directly on the meter in percent or dB. Switchable low-frequency and high-frequency filters are provided to enhance the readout of the harmonic products.

Other features of the Model 1700A include separate Voltage and Distortion measurement range switches, separate Set Level monitoring without range changing, and automatic nulling on all ranges.

The power supply provides regulated dc voltages of +15 volts and -15 volts to power the oscillator and analyzer. Both of these supplies are internally protected against accidental short circuit.

2-2. DISTORTION ANALYZER

2-3. GENERAL DESCRIPTION

Refer to Figure 4-2 for a schematic diagram of the distortion analyzer assembly. Note that the circuit is divided into the following circuit blocks: Buffer amplifier, overload detector, notch filter, distortion amplifier and attenuator, amplitude null filters, function switches, and ac meter. The operation of the assembly is discussed first at a circuit block level and is then followed by details of each block.

In operation, the signal to be measured is connected to the input of the buffer amplifier. This circuit has two outputs: a fixed output which may be connected to the ac voltmeter, and a variable output (controlled by the ADJUST control) which is connected to the notch filter. The voltmeter is an average reading type which measures the signal level selected by the appropriate function switch.

The overload detector monitors the variable output of the buffer amplifier. If an excessively high output voltage is detected, the detector turns on the front panel OVERLOAD indicator.

The notch filter is mechanically ganged to the oscillator frequency select switches and suppresses the fundamental from the output of the buffer amplifier. The output of the notch filter is connected to the input of the distortion amplifier through a step attenuator controlled by the front panel RATIO switch. The attenuator adjusts signal level for the distortion amplifier for various percentages of distortion or ratio readings.

The amplitude null control and phase null control circuits supply the notch filter with its automatic nulling feature. Both circuits monitor the output of the distortion amplifier and feed control signals back to the notch filter.

The sum-point buffer supplies reference signals to the tuning indicator and to the amplitude null control circuit.

The tuning indicator circuit, using frequency information from the notch filter, provides the operator with a visual indication of the frequency being analyzed versus the input frequency. This circuit operates the NOTCH FILTER HIGH and LOW indicators.

The switchable low-frequency and high-frequency filters are connected to the output of the distortion amplifier. This permits them to be selected for DISTORTION and dB VOLTS measurements only.

The switchable low-frequency and high-frequency filters are connected to the output of the distortion amplifier. This permits them to be selected for DISTORTION and dB VOLTS measurements only.

The function switches select the circuit to be measured by the ac voltmeter. When the VOLTS POWER switch is depressed, the meter monitors the output via a stepped attenuator from the buffer amplifier. When the SET LEVEL switch is depressed, the meter monitors the variable output of the buffer amplifier. Operation of the DISTORTION switch routes the signal from the distortion amplifier via the low-frequency and high-frequency filters (if selected) to the meter. When the dB VOLTS switch is depressed, it connects the variable output from the buffer amplifier directly to the attenuator at the input of the distortion amplifier and hence to the meter.

2-4. BUFFER AMPLIFIER

The input of the buffer amplifier contains a pair of step attenuators, one for each INPUT connector. The attenuators are controlled by Sections S1A, B, C, D of the INPUT switch. The attenuator outputs are connected to input signal preamplifiers U101 and U102. The gain of these units is controlled by section S1E of the INPUT switch. Gain is unity on the 3 V range and above, 3.16 on the 1 V range, and 10 on the .3 V range and below. The preamplifier outputs are coupled to U103, a bridge amplifier circuit which effectively acts as a differential to single-ended converter with high common-mode noise rejection. The gain of the bridge amplifier is controlled by ADJUST potentiometer R125 and provides the variable signal supplied by the buffer. The range of gain is 10 dB and full scale voltage is 3.16 volts. The fixed output from the buffer is obtained between the wiper of R125 and ground. This signal remains fixed regardless of the setting of R125, except when the buffer overloads.

2-5. OVERLOAD DETECTOR

The overload detector signals an overload condition when the variable output of the buffer amplifier exceeds approximately 6.5 volts rms sine wave or 9 volts peak. The circuit consists of comparator U107, a half-wave rectifier and filter, a light-emitting diode driver, and OVERLOAD indicator CR120.

2-6. NOTCH FILTER

The notch filter consists of two 90-degree phase shifters connected in series, making the output 180 degrees out of phase with the input. By summing the input and output at summing amplifier U203, the fundamental of the input signal is cancelled out. Feedback from the output of the summing amplifier to the input of the filter increases the Q of the circuit and narrows the rejection band of the filter.

Tuning is controlled by changing a set of RC elements for each phase shifter through operation of the front panel Multiplier and Digit pushbutton switches. When the reactance of the capacitance equals the resistance at the incoming frequency, the phase shift is 90 degrees. The RC components are contained in the frequency module (see Figure 4-5 for schematic diagram).

2-7. DISTORTION AMPLIFIER AND ATTENUATOR

The output of the notch filter is coupled through a 7-step attenuator to the input of distortion amplifier U204. The attenuator is controlled by section S2D of the front panel RATIO switch and reduces the distortion product of the notch filter such that the full scale voltage input to the amplifier is 1 mV on ranges .03% through 100% and .316 mV on the .01% range.

Amplifier U204 is a wide-band high-gain unit with gain controlled by section S2E of the RATIO switch. The gain is 31.6 for ranges .03% through 100% and 100 for the .01% range. This gives a full scale output voltage of 31.6 mV on all ranges.

2-8. AMPLITUDE NULL CONTROL

The amplitude null control circuit controls the amplitude of the signal from the cascaded phase shifter so that exact balance occurs when it is summed with the input to the phase shifters. This ensures the total cancellation of the fundamental signal. The components which perform this function include phase detector U310, floating integrator and voltage follower U312, integrating amplifier U311, integrating capacitors, and a photocoupler controlling a variable resistor element in the summing network.

The reference input to phase detector U310 is a signal which is in phase with the fundamental and the signal input to U310 is the distortion product output of the distortion amplifier. With these inputs, the phase detector monitors the notch filter output for an in-phase signal. When this occurs the output of the phase detector supplies drive to the integrator causing the charge on the integrating capacitors to change. This in turn causes the photocoupler to change the value of the variable resistor which in effect adjusts the summing current until the in-phase component is no longer there.

The integrating capacitors are changed by the RATIO attenuator switch. This in effect maintains the automatic null control loop gain at a relatively constant level, resulting in high-speed nulling on all ranges. The capacitors are precharged to the integrator output voltage level through resistor R360. This avoids switching transients and improves the speed of the circuit.

2-9. PHASE NULL CONTROL

The phase null control circuit fine tunes the phase of the second phase shifter in the notch filter so that the overall phase shift is exactly 180 degrees. This ensures total cancellation of the fundamental signal. The components which perform this function include phase detector U307, floating integrator and voltage follower U309, integrating capacitors, and a photocoupler controlling a variable resistor in the resistive branch of the second phase shifter.

The reference input to phase detector U307 is the distortion product output of the distortion amplifier. With these inputs the phase detector monitors the notch filter output for an out-of-phase signal. When this occurs, the phase detector output supplies drive to the integrator causing the charge on the integrating capacitors to change. The integrator output drives the variable gain amplifier, U313, and the voltage to current converter, U314, which in turn causes the photocoupler to change the value of the variable resistor which in effect adjusts the phase angle until the out-of-phase component is no longer there.

The integrating capacitors are changed by the RATIO attenuator switch. This in effect maintains the automatic null control loop gain at a relatively constant level, resulting in high-speed nulling on all ranges. The capacitors are precharged to the integrator output voltage level through resistor R344. This avoids switching transients and improves the speed of the circuit.

A set of resistors that feed signal from integrator U308 to U313, which acts as a gain control, is switched by the front panel FREQUENCY switches. This maintains a relatively constant integrator voltage when frequency is changed and helps to achieve perfect nulling in less than 5 seconds.

2-10. SUM-POINT BUFFER

The sum-point buffer supplies a signal from the notch filter summing point to the tuning indicator and the amplitude null control, each of which uses the signal as the reference input to a phase detector. The buffer consists of unity-gain amplifier U301 and high-gain high-speed amplifier U302. These components convert the sine wave at the summing point into a square wave signal.

2-11. TUNING INDICATOR

The tuning indicator monitors the phase relationship between the signal input to the notch filter's first phase shifter and its output. The relationship is frequency dependent and is 90 degrees when the incoming frequency is exactly the same as the tuned frequency of the notch filter. The components performing this function include phase detector U303, high-speed amplifier/drivers U304, U305 and HIGH and LOW indicators CR301, CR302.

The reference input to phase detector U303 is the signal at the input to the phase shifter (connected via the sum-point buffer) and the signal input to U303 is the output of the phase shifter. When the incoming frequency is exactly the same as the tuned frequency of the notch filter (90-degree phase relationship), there is no output from the phase detector. Under these conditions both indicators are off. However, if the frequency of the notch filter is high compared with the input frequency, U303 produces a dc output which turns on the HIGH indicator. Conversely, if the frequency of the notch filter is low compared with the input frequency, a dc output of the opposite polarity from U303 turns on the LOW indicator.

2-12. FILTERS

Each filter is an active 3-pole Butterworth having a flat response within its pass-band and an attenuation slope of -18 dB/octave. The -3 dB point is 80 kHz for the low-pass filter and 400 Hz for the high-pass filter.

2-13. FUNCTION SWITCHES

The function switches select the circuit to be measured by the ac voltmeter. When the VOLTS POWER switch is depressed the meter monitors the fixed output, via a step attenuator, from the buffer amplifier. When the SET LEVEL switch is depressed, the meter monitors the signal from a divider connected to the variable output of the buffer amplifier. Operation of the DISTORTION switch routes the signal from the distortion amplifier via the low-frequency and high-frequency filters (if selected) to the meter. This connection is not made directly by the DISTORTION switch but by the release of the SET LEVEL and VOLTS POWER switches which occurs automatically when the DISTORTION switch is depressed. When the dB VOLTS switch is depressed, it connects the variable output from the buffer amplifier directly to the attenuator at the input of the distortion amplifier and hence to the meter.

2-14. AC METER

The ac meter circuit consists of high-gain wide-band amplifier U104, a full-wave bridge rectifier circuit, and dc milliammeter M1. It indicates the average value of an ac signal. The input sensitivity is 31.6 mV full scale. The gain of the meter is adjusted by potentiometer R157.

2-15. OSCILLATOR

2-16. GENERAL DESCRIPTION

Refer to Figure 4-4 for a schematic diagram of the oscillator assembly. The oscillator is basically a Wein bridge type with a unique ultra-low distortion amplitude control circuit. This control circuit provides (1) wide frequency range (2) fast settling (3) flat frequency response and (4) ultra-low distortion. No one of these characteristics is sacrificed in order to achieve an improvement in the others.

The oscillator has two operating modes - Fast Response and Low Distortion. When Fast Response is selected the oscillator amplitude settles quickly after a frequency change; when Low Distortion is chosen, the oscillator settling time to .002% distortion is less than 5 seconds. Built-in control circuitry automatically guides the oscillator through these modes whenever there's disturbance to the amplitude, for example, a change of frequency setting.

2-17. OSCILLATOR CIRCUIT

The basic Wein bridge oscillator consists of a reactive positive feedback network and a resistive negative feedback network, both of which are tied to the output of oscillator amplifier U1. The positive feedback network feeds back to the positive terminal of the amplifier and the negative feedback network is coupled to the negative terminal of the amplifier. Frequency of oscillation is determined in the positive feedback network by the relationship:

$$f = \frac{1}{2 \pi RC}$$

Where front panel Multiplier switches change a set of capacitors for each frequency range and the Digit switches change the resistance value. These components are located in the frequency module (see Figure 4-5 for schematic diagram).

2-18. AMPLITUDE CONTROL

The ultra-low distortion amplitude control circuit consists of two control loops: A high-speed loop and a low-speed loop. These two loops, acting together, effectively vary the negative feedback ratio to regulate the oscillator amplitude.

The high-speed loop, composed of the following major components, stabilizes the oscillator from cycle to cycle.

- a. Peak Detector Q2, Q3.
- b. Active RC filter U2 and associated RC element.
- c. Voltage-controlled resistor (VCR) Q1.

The low-speed loop, consisting of the following major components, monitors the bias applied to the VCR and ensures that the bias is always at an optimum value for low distortion.

- a. Comparator R17, R18 (these components are also input resistors for integrator U3).
- b. Integrator U3 and associated integrating capacitor.
- c. Photocoupler U7.

In the following circuit description, assume that the oscillator has been set for Fast Response operation. In this mode relays K1 and K2 are de-energized, resulting in the following circuit conditions:

- a. The time constant for active RC filter U2 is relatively short.
- b. The time constant for integrator U3 is relatively short.
- c. A high value of resistance is connected in parallel with the VCR section of the negative feedback loop. This allows the VCR to have a wide control range.

In operation, when power is first applied to the unit, there is no input from the oscillator. This causes the output of RC filter U2 to be zero and VCR Q1 to be at its lowest resistance. At the same time, the output of integrator U3 is also zero, which cuts off the drive to the light source in U7. This causes the photoresistor to have a very high resistance. These conditions result in a very low negative feedback ratio in the oscillator, causing it to start immediately after power is applied.

When the oscillator amplitude passes a reference voltage (voltage V2 across R15) at peak detector Q2, Q3, the detector produces an output current which starts to charge up RC filter U2. This in turn creates a large bias voltage (V1) to the VCR which increases its resistance. This tends to lower the amplitude of the oscillator. At the same time, comparator R17, R18 detects that voltage V1 is increasing and when it becomes greater than its reference voltage (V3), the comparator produces a current which drives integrator U3 to turn on the light source in U7. The photoresistor responds by decreasing its resistance, tending to further dampen the amplitude of the oscillator. This action continues until (1) The oscillator amplitude equals the reference voltage (V2) and (2) the VCR bias voltage (V1) equals the reference voltage (V3).

After the oscillator has reached a steady state condition, the circuit continues to operate as follows: Any time the oscillator amplitude is lower than the reference voltage (V2), the ac peak detector Q2, Q3 reduces drive to the RC filter and VCR. This in turn causes the VCR to decrease its resistance, bringing the oscillator amplitude back to the reference level (V2). If the oscillator amplitude is higher than the reference, a reverse action increases the VCR resistance. This operation occurs once per cycle and is performed by the high-speed loop.

The bias (V1) on the VCR is constantly monitored by comparator R17, R18 against reference voltage V3. Any difference in voltage level results in a current of corresponding polarity. This current is integrated constantly by integrator U3. Over a given period of time, if there is an average net increase of VCR bias, there will be an increase of drive to the light source of U7. (The opposite is true for a net decrease of VCR bias). This increase in drive to the light source will result in a decrease of resistance in photoresistor U7. When this occurs, the VCR is no longer required to have such a high resistance and hence high bias voltage V1. Therefore, the bias voltage (V1) for the VCR will gradually return to its predetermined value, the reference voltage V3. This action, which provides a constant optimum bias for the VCR, is performed by the low-speed loop.

Now assume that the oscillator has been set for Low Distortion operation and it is in a steady state condition. At this time, relays K1 and K2 are energized resulting in the following circuit conditions:

- a. The time constant for active RC filter U2 is now longer. This filters the sawtooth voltage driving VCR Q1 to almost a dc level, minimizing its distortion effect.
- b. The time constant for integrator U3 is now longer. This ensures that the stability of the control system is maintained.
- c. Resistor R8 is shunted in parallel with VCR Q1. This greatly limits the control range of the VCR, reducing its distortion effort.

The oscillator remains in this state until a disturbance to the oscillator amplitude occurs. At this time, the high-speed loop, in an attempt to maintain the oscillator amplitude, creates an abnormal bias level for VCR Q1. This level is sensed by level detector Q4, Q5 which in turn triggers one-shots U6A, U6B with the result that relays K1 and K2 are de-energized. This places the amplitude control system in the Fast Response mode previously discussed. The system remains in this state for $2\frac{1}{2}$ seconds.

At the end of the $2\frac{1}{2}$ second interval, relay K1 is energized. This causes the following circuit action:

- a. A shunt is placed across VCR Q1 to limit its control range.
- b. The time constant of integrator U3 is increased to maintain circuit stability.
- c. A large capacitor is allowed to charge to the steady state output value of active RC filter U2.
- d. A large capacitor is allowed to charge to the steady state output value of integrator U3.

During this intermediate state, which also lasts $2\frac{1}{2}$ seconds, the oscillator settles to a steady state condition. At the end of this interval, relay K2 is energized. This causes the following circuit action:

- a. The precharged capacitor is connected across RC filter U2.
- b. The precharged capacitor is connected across the integrator U3.

Thus, after 5 seconds, the control system is back in the ultra-low distortion mode with relays K1 and K2 energized.

2-19. POWER SUPPLY

2-20. GENERAL DESCRIPTION

Refer to Figure 4-7 for a schematic diagram of the power supply. The assembly consists of a regulated +15 Vdc supply and a regulated -15 Vdc supply, both of which feature current foldback and current limiting.

2-21. INPUT CIRCUIT

Main power is coupled to the primary of transformer T1 via POWER switch S3, 115/230 Vac select switch S5, and fuse F1. Transformer T1 steps the main voltage down to the appropriate level for the individual power supply circuits.

2-22. +15 Vdc SUPPLY

Full wave rectifier CR601-604 and filter capacitor C601, connected to a secondary winding on T1, produce an unregulated output of approximately +28 Vdc. The regulation circuit includes pass element Q601, and integrated circuit regulator U601. Potentiometer R603 allows the output to be set to exactly +15 Vdc.

2-23. -15 Vdc SUPPLY

The -15 Vdc supply is similar to the +15 Vdc supply described above except that the outputs are reversed, resulting in a negative potential with respect to power supply ground. Also, the output of this supply is not adjustable.

SECTION III MAINTENANCE

3-1. INTRODUCTION

This section provides performance checks, adjustment and calibration procedures, troubleshooting techniques, and repair instructions for the Model 1700A.

3-2. TEST EQUIPMENT

Recommended test equipment for performance checking and troubleshooting is listed in Table 3-1. Test instruments other than those described can be used provided their specifications equal or exceed those listed.

3-3. PERFORMANCE CHECK

CAUTION

Due to the ultra-low distortion characteristics of the Model 1700A, only test equipment with the specifications described in Table 3-1 is capable of making the distortion measurements called for in this check. Use of test equipment with equal or higher residual distortion to measure, for example, the low distortion oscillator, will result in erroneous readings due to:

- a. Residual distortion of measuring equipment.
- b. Reinforcement or cancellation effect of distortion products.

3-4. GENERAL INFORMATION

This check can be used as an incoming inspection check and the Overall System Check portion (Paragraph 3-5) can be used as a quick method of verifying correct system operation. If the correct results are not obtained, refer to the information contained in Troubleshooting (Paragraph 3-29).

Before beginning the check, ensure that all external equipment (oscilloscope, amplifier under test, etc.) is completely disconnected from the Model 1700A. Also ensure that none of the fuses described in paragraph 3-29 are blown.

3-5. OVERALL SYSTEM CHECK

3-6. Distortion Test

NOTE

1. Before beginning the test, ensure that all external equipment is completely disconnected from the Model 1700A.

2. This test measures the overall distortion of the system, with distortion from both the oscillator and the distortion analyzer contributing to the result. To measure the distortion of the analyzer assembly, an extremely pure source with a distortion of .0002% is required.

- a. Connect cable between SIGNAL OUTPUT BNC connector and INPUT terminals. Use - (minus) terminal for BNC shell.
- b. Set Model 1700A controls as follows:


SIGNAL COMMON switch-----	
INPUT switch-----	3 V
ADJUST control-----	CAL
OSCILLATOR LEVEL control-----	fully CW (max. level)
FAST RESPONSE/LOW DISTORTION switch-----	LOW DISTORTION
FREQUENCY pushbutton-----	X10
	100 = 1000 Hz
FILTERS pushbuttons-----	80 kHz

Table 3-1 Required Test Equipment

TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
AC Calibrator	Voltages: 316.2 mV, 1.000 mV, 3.162 V rms Accuracy: $\pm .1\%$ at 1 kHz	Adjustment and Calibration	Fluke Model 5200A (*See alternate method described below).
Digital Multi-Meter	DC Voltage Range: 200 mV to 200 V $\pm .1\%$ AC Voltage Range: 200 mV to 200 V $\pm .5\%$ Resistance Range: 200 ohms to 20 M ohms $\pm .2\%$	Adjustment and Calibration Troubleshooting	Fluke Model 8000A
Frequency Counter	Frequency Range: 10 Hz to 110 kHz Period Measurements: 10 Hz to 1 kHz Accuracy: $\pm .1\%$	Adjustment and Calibration Troubleshooting	Fluke Model 1900A
Oscilloscope	Bandwidth: DC to 10 MHz Vertical: Dual Channel	Adjustment and Calibration Troubleshooting	Hewlett-Packard Model 1220A or Philips Model PM3232
Oscillator and THD Analyzer	Frequency Range: 10 Hz to 110 kHz Residual Distortion: .002%, 10 Hz to 10 kHz	Troubleshooting	Sound Technology Model 1700A


*To produce fairly accurate AC voltages: For 3.00 Vrms -- Monitor oscillator output with Digital Multimeter.

For 1.000 Vrms -- Set 1700A under test to 100 V range and set oscillator output for a 31.6 mV rms output with Digital Multimeter.

For .3162 mVrms -- Same as above except set 1700A under test to 300 V range.

- | <u>Multiplier</u> | <u>Digit</u> | <u>Frequency</u> | <u>Distortion</u> |
|-------------------|--------------|------------------|-------------------|
| X10 | 10 | 100 Hz | .004 |
| X1 | 10 | 10 Hz | .0045 |
| X1 | 100 | 100 Hz | .004 |
| X100 | 100 | 10 kHz | .004 |
| X100 | 10 | 1 kHz | .004 |
| X1000 | 10 | 10 kHz | .004 |

- ### 3-7. Circuit Common Isolation Check

- | <u>SIGNAL COMMON switch</u> | <u>Resistance</u> |
|--|------------------------|
| FLOAT
 | >10 megohm
<0.5 ohm |

- ### 3-8. OSCILLATOR CHECK

3-9. Frequency Test

- ```

OSCILLATOR LEVEL control----- fully CW
FAST RESPONSE/LOW DISTORTION switch----- FAST RESPONSE
FREQUENCY pushbuttons----- X10 = 1 kHz
 100

```

- ### NOTE

The Model 1700A can be used to measure the ac voltage. If this is done, the drop in response at 10 Hz is caused by the characteristics of the voltmeter and not the oscillator.

| <u>Multiplier</u> | <u>Digit*</u> | <u>Frequency</u> |
|-------------------|---------------|------------------|
| X10               | 10            | 100 Hz           |
| X1                | 10            | 10 Hz            |
| X1                | 100           | 100 Hz           |
| X100              | 100           | 10 kHz           |
| X100              | 10            | 1 kHz            |
| X1000             | 10            | 10 kHz           |

```
*Set remaining digits to 0.
```

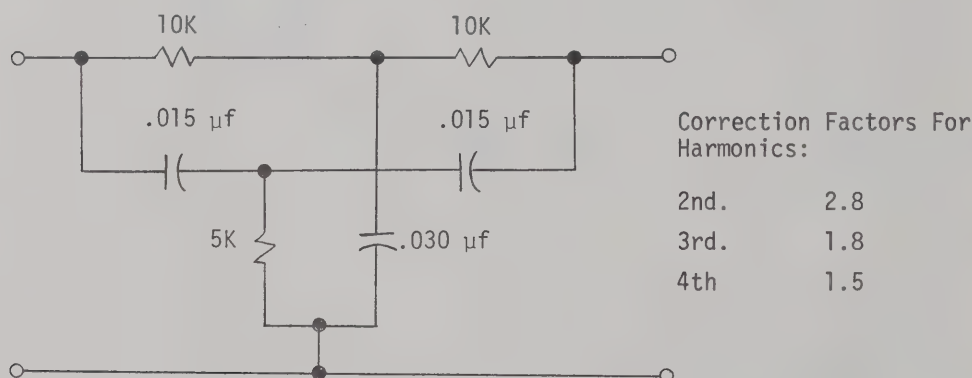
### 3-10. Distortion Test

- a. Set FAST RESPONSE/LOW DISTORTION Switch to LOW DISTORTION and set ADJUST control to CAL.
- b. Measure distortion of oscillator at frequencies listed in Paragraph 3-9.

#### NOTE

The measurement technique for making oscillator distortion measurements (and the accuracy of the reading) depends on the type of test equipment available to the user. In general, this equipment will fall into the following three categories, listed below in order of measurement accuracy:

1. Model 1700A. In the absence of a wave analyzer, the Model 1700A can be used to make a rough check of the oscillator's distortion. Carry out the Distortion Test described in Paragraph 3-6.
2. Wave analyzer with a residual distortion of less than -60 dB. Set the Model 1700A to the 3V range and adjust the OSCILLATOR LEVEL control for a set level mark of -10 dB. Then use the wave analyzer to sort out the harmonic distortion products of the oscillator. This measurement is, in general, accurate to approximately .0005%.
3. Wave analyzer with a residual distortion of less than -80 dB. Set the oscillator output as described in 2 above. Connect a twin-T filter, which must attenuate the fundamental by at least 40 dB, ahead of the wave analyzer. Then use the wave analyzer to sort out the harmonic distortion products. This method is, in general, accurate to .0001% or 1 ppm. A suitable twin-T network for 1.06 kHz is shown in Figure 3-2.



NOTE: All resistors are metal-film type,  $\pm 1\%$  tolerance  
All capacitors are polystyrene type,  $\pm 1\%$  tolerance

FIG. 3-2

### 3-11. DISTORTION ANALYZER CHECK

### 3-12. dB Volts Test

- a. Set Model 1700A controls as follows:

|                                          |                |
|------------------------------------------|----------------|
| INPUT switch-----                        | 30 V           |
| OSCILLATOR LEVEL control-----            | fully CCW      |
| FAST RESPONSE/LOW DISTORTION switch----- | LOW DISTORTION |
| LOW DISTORTION switch-----               | X10 = 1000 Hz  |
|                                          | 100            |
| RATIO switch-----                        | .01            |
| SIGNAL COMMON switch-----                |                |




- b. Depress dB VOLTS pushbutton and adjust OSCILLATOR LEVEL control for full scale reading on meter.
- c. Set RATIO switch to next higher range and check that signal drops by approximately 10 dB.
- d. Again adjust OSCILLATOR LEVEL control for a full scale reading and then set RATIO switch to next higher range. Check that signal again drops by approximately 10 dB.
- e. Repeat this operation until a -10 dB reading on 10% range is reached. At this time, set OSCILLATOR LEVEL control fully clockwise and then rotate ADJUST control for a full scale reading.
- f. Set RATIO switch to 30% range and check that signal drops approximately 10 dB.

Rotate ADJUST control for full-scale reading. Set RATIO switch to 100% range. Check that signal drops approximately 10 dB.

### 3-13. Volts Power Test


- a. Set Model 1700A controls as follows:

|                                          |                                                                                    |
|------------------------------------------|------------------------------------------------------------------------------------|
| INPUT switch-----                        | .003 V                                                                             |
| ADJUST control-----                      | CAL                                                                                |
| OSCILLATOR LEVEL control-----            | fully CCW                                                                          |
| FAST RESPONSE/LOW DISTORTION switch----- | FAST RESPONSE                                                                      |
| FREQUENCY pushbuttons-----               | X10 = 1000 Hz                                                                      |
|                                          | 100                                                                                |
| SIGNAL COMMON switch-----                |  |

- b. Depress VOLTS POWER pushbutton and adjust OSCILLATOR LEVEL control until meter pointer indicates full scale.
- c. Set INPUT switch to next higher range and check that signal drops by approximately 10 dB.
- d. Again adjust OSCILLATOR LEVEL control for a full scale reading and then set INPUT switch to next higher range. Check that signal again drops by approximately 10 dB.
- e. Repeat this operation until 3 volt range is reached. At this time turn OSCILLATOR LEVEL control fully clockwise. Now up range INPUT switch through the remainder of its ranges, checking that signal drops by approximately 10 dB on each range.

### 3-14. Filters Test

- a. Set Model 1700A controls as follows:

|                                          |                                                                                      |
|------------------------------------------|--------------------------------------------------------------------------------------|
| INPUT switch-----                        | 3 V                                                                                  |
| ADJUST control-----                      | CAL                                                                                  |
| OSCILLATOR LEVEL control-----            | fully CW                                                                             |
| FAST RESPONSE/LOW DISTORTION switch----- | LOW DISTORTION                                                                       |
| FREQUENCY pushbuttons-----               | X10 = 400 Hz                                                                         |
|                                          | 40                                                                                   |
| RATIO switch-----                        | 0 dB                                                                                 |
| SIGNAL COMMON switch-----                |  |

- b. Depress dB VOLTS pushbutton and set ADJUST control for a 0 dB meter reading.
- c. Depress 400 Hz FILTERS pushbutton. Check meter for a -3 dB reading.
- d. Release 400 Hz FILTERS pushbutton.
- e. Set oscillator frequency to 80 kHz (depress X1000 and 80 pushbuttons) and depress 80 kHz FILTERS pushbutton. Check that signal attenuation is -3 dB or more.

### 3-15. Residual Noise Test

- a. Set Model 1700A controls as follows:

|                                          |                |
|------------------------------------------|----------------|
| INPUT switch-----                        | 3 V            |
| ADJUST control-----                      | CAL            |
| OSCILLATOR LEVEL control-----            | fully CW       |
| FAST RESPONSE/LOW DISTORTION switch----- | LOW DISTORTION |
| FREQUENCY pushbuttons-----               | X10 = 1000 Hz  |
|                                          | 100            |
| FILTERS pushbuttons-----                 | 80 kHz         |
| SIGNAL COMMON switch-----                | $\nearrow$     |

- b. Depress SET LEVEL pushbutton and adjust OSCILLATOR LEVEL control until meter pointer is at SET LEVEL mark.
- c. Depress DISTORTION pushbutton and set RATIO switch to .01 range. (This reading is noise and distortion of oscillator and analyzer).
- d. Depress SET LEVEL pushbutton and adjust OSCILLATOR LEVEL control for a meter reading of -15 dB. (This greatly reduces the level of the signal input to the analyzer with the result that almost all of the distortion products are eliminated and only the residual noise of the analyzer remains).
- e. Depress DISTORTION pushbutton. Check that meter reading is less than .0025%.
- f. Remove cable connected between SIGNAL OUTPUT connector and INPUT terminals.
- g. Place a shorting link between INPUT terminals and connect to COM ( $\nabla$ ) terminal.
- h. Depress dB VOLTS pushbutton and set controls as follows (meter full-scale sensitivity is now 30  $\mu$ V).

|                     |                 |
|---------------------|-----------------|
| INPUT switch-----   | .3 V            |
| ADJUST control----- | CAL (fully CCW) |
| RATIO-----          | .01%            |

- i. Depress 80 kHz FILTERS pushbutton and check that meter reading is less than 8  $\mu$ V.
- j. Release 80 kHz pushbutton and check that reading is less than 15  $\mu$ V.

### 3-16. Common Mode Rejection Test

- a. Connect SIGNAL OUTPUT BNC connector to INPUT terminals and set oscillator frequency to 60 Hz (depress X1 and 60 pushbuttons).
- b. Depress VOLTS POWER pushbutton and adjust OSCILLATOR LEVEL control for a meter reading of 1 volt.
- c. Remove cable from INPUT terminals and short + and - INPUT terminals together. Now connect input cable between - INPUT and GND ( $\nearrow$ ) terminals.
- d. Set RATIO switch to -20 dB range and ADJUST control to CAL position.
- e. Depress dB VOLTS pushbutton. Check that meter reading is -20 dB or lower.

### 3-17. ADJUSTMENT and CALIBRATION PROCEDURE

The following is a complete adjustment and calibration procedure for the Model 1700A. The procedure should be carried out only when the Performance check (Paragraph 3-3) indicates that adjustments are required. If the Model 1700A does not meet the test limits specified in the following steps, consult the troubleshooting information provided in Paragraph 3-29. The location of the adjustment controls in the analyzer, oscillator, and power supply are shown in Figures 4-1, 4-3, and 4-6 respectively.

### 3-18. OSCILLATOR SECTION

#### 3-19. +15 Volt Adjustment

- a. Connect HI lead of digital voltmeter (DVM) to +15 volt terminal and LO lead to GND terminal on power supply assembly.
- b. Adjust potentiometer R603 for DVM reading of +15.000,  $\pm$  .010 V.

#### 3-20. PhotoCell AC Voltage Adjustment

- a. Set Model 1700A controls as follows:

FREQUENCY pushbutton-----X10  
10 = 100 Hz  
FAST RESPONSE/LOW DISTORTION switch----- FAST RESPONSE

- b. Connect HI lead of DVM to junction of R3 and R4; connect DVM LO lead to "0" terminal (oscillator output) on oscillator board.
- c. Adjust R5 for AC voltage reading of .20V.

#### NOTE

Clockwise rotation of R5 decreases voltage, counterclockwise rotation increases voltage.

#### 3-21. Oscillator Integrator Voltage Change Adjustment

- a. Set Model 1700A controls as follows:

FREQUENCY pushbutton-----X10  
10 = 100 Hz  
FAST RESPONSE/LOW DISTORTION switch----- FAST RESPONSE

- b. Connect DVM HI lead to TP6 and LO lead to GND.
- c. Connect TP3 to GND with clip lead. Note dc voltage reading on DVM.
- d. Remove clip lead from TP3. Adjust potentiometer R7 for same dc voltage noted in Step c.  $\pm$  .005 V.

#### NOTE

The following is an alternative method of measuring the TP6 voltage with a floating VTVM:

Connect LO terminal of VTVM to positive terminal of C603 on power supply board and the HI terminal to TP6. (In this case, the dc potential at C603 is used as a bucking voltage so that the VTVM can be set to a lower (more sensitive) range to resolve the required 5 mV).

#### 3-22. Oscillator Integrator Output Adjustment

#### CAUTION

If the photocoupler has been replaced, allow at least 10 minutes to elapse before proceeding with this adjustment. This is to allow the unit (and the technician!) to cool off after soldering.

- a. Set Model 1700A controls as follows:

FREQUENCY pushbuttons----- X10 = 100 Hz  
 10  
 FAST RESPONSE/LOW DISTORTION switch----- FAST RESPONSE

- b. Connect DVM HI lead to TP6 and LO lead to GND. Adjust R20 for +6.5\* volts dc at TP6.

\*The 6.5 V setting is for a dark adapted photocoupler. This is a photocoupler which has been in the off state for the last 24 hours (instrument power off). It is normal for the voltage at TP6 to gradually increase with time.

If the dc voltage at TP6 is greater than +8 V after the instrument has been on for 24 hours or more, readjust R20 for +8 V at TP6.

### 3-23. Oscillator X1000 Frequency Range Adjustment

- a. Depress Model 1700A X1000 Multiplier and 1st Digit 10 FREQUENCY pushbuttons. Set 2nd and 3rd Digits to zero.
- b. Monitor (1) dc voltage between TP6 and GND and (2) frequency of oscillator.
- c. Adjust trimmer capacitors across C33 and C38 with an insulated trimmer tool until (1) dc voltage is in range of 6.5 V to 8 volts and (2) frequency is 10.0 kHz  $\pm$  1.5%.
- d. Depress 100 Digit FREQUENCY pushbutton. Check that (1) dc voltage is in range of 6.5 to 8 volts and (2) frequency is 100 kHz  $\pm$  1.5%.
- e. Repeat Steps c. and d. until voltage and frequency readings are within specifications stated.

### 3-24. ANALYZER SECTION

#### 3-25. Dc Zero Adjustment

- a. Connect a short between +INPUT, -INPUT and COM ( $\nabla$ ) terminals.
- b. Set Model 1700A controls as follows:

INPUT switch----- .3 V  
 ADJUST control----- fully CW

- c. Connect DVM HI lead to TPI and LO lead to TP2. Adjust potentiometer R219 for a DVM reading of zero volts  $\pm$  10 mV.
- d. Connect DVM HI lead to negative side of capacitor C209. Adjust potentiometer R217 for DVM reading of zero volts  $\pm$  10 mV.
- e. Connect DVM HI lead to TP9 (located at rear of board).
- f. Set Model 1700A controls as follows:

INPUT switch----- 3 V  
 ADJUST control----- CAL (fully CCW)  
 RATIO switch----- .01

- g. Adjust potentiometer R234 for reading of zero volts  $\pm$  10 mV.

#### 3-26. Null Adjustment

- a. Set Model 1700A controls as follows:

INPUT switch----- 3 V  
 ADJUST control----- CAL (fully CCW)  
 RATIO switch----- 10%  
 DISTORTION pushbutton----- depressed



|                                          |                                |
|------------------------------------------|--------------------------------|
| SIGNAL COMMON switch-----                | $\overline{\text{H}}$ (ground) |
| FREQUENCY pushbuttons-----               | X10 = 100 Hz                   |
|                                          | 10                             |
| OSCILLATOR LEVEL control-----            | fully CW                       |
| LOW DISTORTION/FAST RESPONSE switch----- | LOW DISTORTION                 |
| FILTERS-----                             | 80 kHz depressed               |

- b. Connect cable between SIGNAL OUTPUT connector and INPUT terminals.
- c. Connect one channel of oscilloscope to BUFFERED INPUT SIGNAL connector (at rear of instrument).
- d. Adjust oscilloscope so that waveform is synched to Buffered Input Signal.
- e. Monitor waveform at pin 6 of U312 with the other scope channel.
- f. Adjust R351 for minimum fundamental signal at pin 6 of U312.
- g. Now, monitor waveform at DISTORTION OUTPUT.
- h. Adjust potentiometers R337 and R354 until Distortion output waveform contains no fundamental signal.

### 3-26A. Phase Null Integrator Voltage Adjustment

- a. Set Model 1700A controls as described in Paragraph 3-6, Steps a. through d.
- b. Connect DVM HI lead to TP9 and LO lead to TP6.
- c. Adjust R364 for a dc voltage reading of 2.8V\*.

\*The 2.8V setting is for a dark adapted photocoupler. This is a photocoupler which has been in the off state for the last 24 hours (instrument power off). It is normal for the voltage at TP6 to gradually increase with time.

If the dc voltage between TP9 and TP6 is greater than 3.0 V after the instrument has been on for 24 hours or more, readjust R364 for 3.0 V.

### 3-27. Tuning Indicator Adjustment

- a. Set Model 1700A controls as follows:

INPUT switch----- 3 V  
 ADJUST control----- CAL (fully CCW)  
 RATIO switch----- 1%  
 FREQUENCY pushbuttons----- X10 (2nd. and 3rd. digits to zero)  
 OSCILLATOR LEVEL control----- fully CW  
 FAST RESPONSE/LOW DISTORTION----- FAST RESPONSE  
 SIGNAL COMMON switch-----  $\uparrow$  (ground)

- b. Connect DVM LO lead to green wire connected to NOTCH FREQUENCY indicators and HI lead to junction of R320 and pin 6 of U305.  
 c. Depress in turn each FREQUENCY 1st digit pushbutton and observe DVM voltage readings. Record (1) digit giving most positive reading and its value and (2) digit giving most negative reading and its value.  
 d. Depress X1 Multiplier FREQUENCY pushbutton, and repeat procedure described in Step c.  
 e. Depress X100 Multiplier FREQUENCY pushbutton and repeat procedure described in Step c.  
 f. Review all readings recorded and determine (1) most positive value and (2) most negative value. Add these two values together (to determine voltage range) and then divide number by 2 (to determine mid-point).  
 g. Depress digit previously determined to have most positive reading and adjust potentiometer R312 until DVM indicates mid-point value determined in Step f. See example below:


| <u>Multiplier</u> | <u>Most Pos. Digit</u> | <u>Most Neg. Digit</u> |
|-------------------|------------------------|------------------------|
| X10               | 60, + 1.0 V            | 50, + .20 V            |
| X1                | 60, - .20 V            | 50, - .70 V            |
| X100              | 60, + .01 V            | 50, - .60 V            |


Overall most positive = X10, 60 = + 1.0 V  
 Overall most negative = X1, 50 = - .70 V  
 Range = 1.70 V, mid-point = .85 V  
 Adjust X10, 60 for + .85 V

- h. Depress X1000 Multiplier pushbutton and repeat Steps c. and f.  
 i. Now depress digit giving most positive value and using a non-metallic screwdriver, adjust trimmer capacitor accessible through hole in shield on right-hand side of instrument for mid-point value determined in repeat of step f.

### 3-28. Calibration at 1 kHz

- a. Set Model 1700A controls as follows:

|                             |                                                                                             |
|-----------------------------|---------------------------------------------------------------------------------------------|
| VOLTS POWER pushbutton----- | depressed                                                                                   |
| FILTERS-----                | out                                                                                         |
| FREQUENCY pushbutton-----   | X10 = 1 kHz                                                                                 |
|                             | 100                                                                                         |
| INPUT switch-----           | 3 V                                                                                         |
| ADJUST control-----         | CAL (fully CCW)                                                                             |
| RATIO switch-----           | .03%                                                                                        |
| SIGNAL COMMON switch-----   |  (ground) |

- b. Set meter mechanical zeroing as described in Paragraph 1-12.
- c. Apply an accurate  $3.162 \text{ V} \pm 0.1\%$  or better 1 kHz signal between +INPUT and -INPUT terminals. Connect low side of test signal to -INPUT.
- d. Connect chassis of precision ac source to GND () terminal on Model 1700A.
- e. Adjust Meter Sensitivity potentiometer R157 for an exact full-scale reading (1.0 mark on VOLTS scale) on meter.
- f. Depress SET LEVEL pushbutton. Adjust Set Level potentiometer R146 for an exact full-scale reading.
- g. Change input signal level to 1.000 mV. Depress dB VOLTS pushbutton and adjust Distortion Amplifier Gain potentiometer R237 for an exact full-scale reading.
- h. Change input signal level to .3162 mV and set RATIO switch to .01%. Adjust Distortion Amplifier Gain potentiometer R239 for an exact full-scale reading.

### 3-29. TROUBLESHOOTING

Check the two 3AG 1 Amp fuses located on bottom of instrument.

Before attempting to troubleshoot the Model 1700A, ensure that the fault is with the Model 1700A and not caused by the test setup or associated equipment. The Performance Check (Paragraph 3-3 enables this to be determined without having to remove the covers from the Model 1700A.

If an abnormal condition is observed during the Performance Check, Table 3-2 will suggest remedies. However, before proceeding with detailed troubleshooting, note the following suggestions:

- a. A good understanding of the principles of operation of the Model 1700A will assist the troubleshooter and it is recommended that the reader be familiar with the contents of Section II of this manual.
- b. Any suspected malfunction should first be tested with the Performance Check. This need not be carried out in its entirety ---- only the portion applicable to the suspected malfunction need be performed.
- c. Verify proper power supply operation by measuring the +15 Vdc and -15 Vdc voltages. Check also the +12, -6 and -8 Vdc supplies which operate the null control circuits on the analyzer board.
- d. Many measurement problems or bad readings can be related to incorrect grounding. Refer to Paragraph 1-8 for correct grounding instructions.
- e. The differential input circuitry of the Model 1700A requires a return to circuit common. Check the input cabling for proper connections.
- f. Attempt to isolate the malfunction to either the oscillator or the distortion analyzer. After this, try to isolate the fault to a circuit block within the suspected unit.

- g. Determine component failure within the analyzer by operating the Model 1700A without an input signal and then comparing dc levels with those marked on the schematic.
- h. Since the instrument contains a number of identical components mounted in plug-in sockets, it is permissible to switch these units in order to isolate a malfunction. However, known good components must always be returned to their original locations.
- i. Phase detector U303 in the tuning indicator need not be in position for proper notch filter operation. This component can therefore be used to isolate a malfunction in the null control circuits. But be sure to return the original I.C. to U303 when done.
- j. Abnormally large potentials (more than  $\pm 15$  mV) measured between the + and - input terminals on operational amplifiers generally indicate a defective amplifier.
- k. When a malfunction occurs try first to find out if the trouble relates to any particular pushbutton. If it does, it may be possible to cure the problem by depressing and releasing the defective button several times.

### 3-30. SYMPTOM/CAUSE TABLE

Table 3-2 contains symptoms of Model 1700A malfunctions and provides diagnostic tests for the location of these faults. Before beginning detailed troubleshooting, the reader is advised to study notes a. through k. in Paragraph 3-29.

Following the replacement of a defective component, refer to Paragraph 3-31 for instructions regarding any necessary calibration and/or adjustment procedures.

### 3-31. COMPONENT REPLACEMENT - CALIBRATION and ADJUSTMENT

Portions of the Model 1700A Adjustment and Calibration Procedure (Paragraphs 3-18) and other adjustments must be completed following the replacement of certain components in the instrument. These components, and the applicable Adjustment/Calibration Procedures are as listed below:

| <u>Component</u>                                             | <u>Required Adjustment/Calibration Procedure</u>                                                                                     |
|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| a. Photocoupler U7<br>(Oscillator)                           | Oscillator Integrator<br>Output Adjustment (Paragraph 3-22)                                                                          |
| b. Voltage - controlled<br>resistor Q1<br>(Oscillator)       | Oscillator Integrator Voltage<br>Change Adjustment (Paragraph 3-21)                                                                  |
| c. Operational Amplifier<br>U1 (Oscillator)                  | Oscillator X1000 Frequency Range<br>Adjustment (Paragraph 3-23)                                                                      |
| d. Operational Amplifiers<br>2605, 2625<br>(Analyzer)        | DC Zero Adjustment - related<br>adjustment (Paragraph 3-25)                                                                          |
| e. Meter M1<br>(Analyzer)                                    | Calibration at 1 kHz<br>(Paragraph 3-28)                                                                                             |
| f. Phase detectors<br>U307, U310<br>(Analyzer, null control) | Null Adjustment<br>(Paragraph 3-26)                                                                                                  |
| g. Phase detector<br>U303<br>(Analyzer, tuning<br>Indicator) | Tuning Indicator Adjustment<br>(Paragraph 3-27)                                                                                      |
| h. Photocoupler U205<br>(Analyzer, phase<br>null control)    | Allow 10 minutes for the photocoupler to cool<br>off after soldering. Phase Null Integrator<br>Voltage Adjustment (Paragraph 3-26A). |



- i. Photocoupler U206  
(Analyzer, amplitude  
null control)

Allow 10 minutes for the photocoupler to cool off after soldering. Set controls as described above. Connect DVM HI lead to TP8 and LO lead to TP7. Reading is dc voltage across R359. Calculate current through it. If necessary, select new value for R359, such that  $1.4 \pm .2$  V is developed across it. Replace R359.

### 3-32. REPLACEMENT and REPAIR

### 3-33. SPECIAL PRECAUTIONS

### 3-34. Contamination

The performance of the Model 1700A will be greatly degraded by contamination of the circuit-board surfaces or components. Finger marks and oil droplets are contaminants to be especially avoided. To minimize the possibility of contamination, observe the following precautions:

- a. Do not disassemble any portion of the Model 1700A unless absolutely necessary (for example, to replace relays on oscillator board or to service frequency modules.)
- b. Avoid any unnecessary handling of the printed-circuit boards or components. Replace components from the top side of the boards only.
- c. Employ only the soldering and component replacement techniques described in Paragraphs 3-36 through 3-39.

### 3-35. WIRING

Lead dress within the instrument should not be altered. This is especially important with the wires running between the rotary switches and the distortion analyzer assembly. Before removing an assembly with wires attached, make a sketch showing the exact arrangement of the wires so that they may be replaced in the same manner.

### 3-36. SOLDERING TECHNIQUES

- a. Use a low-wattage iron with a pencil-shaped tip and allow it to reach full operating temperature before use. A fully-heated iron ensures the quick completion of soldering and minimizes the chance that the etched wiring on the printed-circuit boards will be damaged by excessive heat.
- b. Before using the soldering iron, wipe it off to remove excess solder and oxide.
- c. Use only a solder with non-corrosive non-conductive flux. Do not use acid-cored solder.
- d. Do not clean off the rosin around the soldered joint with a wire brush or metal scribe. This will destroy the high electrical resistance of the board.

### 3-37. COMPONENT REPLACEMENT

#### CAUTION

The use of Soder-Wick\* (rosin-impregnated copper braid) or a similar product is highly recommended for the removal of solder during the de-soldering operation. If it is not available, and a vacuum-type de-soldering tool is employed, ensure that it is cleaned before use. This is to prevent the possibility of conductive debris being sprayed on the board during the de-soldering process.

---

\*Soder-Wick may be obtained from Solder Removal Company, Covina, CA, U.S.A.

Table 3-2

| SYMPTOM                                                    | PROBABLE CAUSE                                                                                                                               | DIAGNOSTIC TEST                                                                                                                                      |
|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| Oscillator will not settle down to low distortion mode     | Photo-coupler, U7<br>VCR, Q1<br>R7 out of adjustment                                                                                         | Replace photo-coupler<br>Replace VCR<br>Do oscillator Integrator Change Adjustment (Paragraph 3-21)                                                  |
|                                                            | Dual Timer, U6                                                                                                                               | Replace U6                                                                                                                                           |
|                                                            | Oscillator amp. U1                                                                                                                           | Replace U1                                                                                                                                           |
| Oscillator has excessive unstable distortion readings      | Photo-coupler, U7<br>VCR, Q1<br>Oscillator amp., U1                                                                                          | Replace U7<br>Replace Q1<br>Replace U1                                                                                                               |
| Oscillator has excessive third harmonic distortion         | Photo-coupler, U7                                                                                                                            | Replace U7                                                                                                                                           |
| Oscillator produces clipped waveforms                      | Photo-coupler, U7<br>RC filter amplifier, U2<br>Integrator Amplifier, U3<br>Oscillator Amp., U1<br>Peak detectors, Q2, Q3                    | Replace U7<br>Replace U2<br>Replace U3<br>Replace U1<br>Replace Q2 or Q3                                                                             |
| Oscillator has no output on all frequencies                | Oscillator Amp., U1                                                                                                                          | Replace U1                                                                                                                                           |
| Oscillator has hum output                                  | Improper ground connections or Float switch set to ground (⏏) position                                                                       | Check that ground and connections are in compliance with Paragraphs 1-8 and 1-9                                                                      |
| Hum in distortion output                                   | Missing chassis connection between 1700A and scope                                                                                           | Check that connections are in compliance with Paragraphs 1-8 and 1-9                                                                                 |
| Distortion reading contains excessive hum                  | Missing ground return for 1700A differential front end                                                                                       | Check that connections are in compliance with Paragraphs 1-8 and 1-9                                                                                 |
| High distortion reading under all conditions (Not Nulling) | Amplitude Null Circuit (U302, U310, U311, U312)<br>Photo-coupler, U206<br>Phase Null Circuit (U306, U307, U308, U309)<br>Photo-coupler, U205 | Check D.C. voltages on Null circuit without input signal<br>Replace U206<br>Check D.C. voltages on Null circuit without input signal<br>Replace U205 |

Table 3-2, Continued

| SYMPTOM                                                                                  | PROBABLE CAUSE                                                                       | DIAGNOSTIC TEST                                                                                                                                                                                                                                     |
|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| High distortion reading under all conditions (Not Nulling), Cont.                        | Notch Filter (U201, U202, U203, U301)                                                | Open feedback loop by lifting up one end of R203 (100 ohms). Check D.C. voltages on Notch Filter circuit without input signal                                                                                                                       |
|                                                                                          | Leaky zener diode CR304 or CR305                                                     | Disconnect zener from circuit while operating in Distortion Function                                                                                                                                                                                |
| One of Notch frequency lights stays ON during measurement on all frequencies             | Tuning indicator circuit (U303, U304, U305)                                          | Check D.C. voltages on circuit without input signal                                                                                                                                                                                                 |
|                                                                                          | Phase detector, U303                                                                 | Replace U303                                                                                                                                                                                                                                        |
|                                                                                          | R312 out of adjustment                                                               | Do tuning indicator adjustment (Paragraph 3-27)                                                                                                                                                                                                     |
| Analyzer has excessive unstable distortion readings                                      | Photo-coupler U205 or U206                                                           | Make certain the symptom is from the analyzer section and not the oscillator section. Then replace U205 or U206                                                                                                                                     |
| One of notch frequency lights stays ON during distortion measurement on some frequencies | Oscillator frequency drifted out of $\pm 2\%$ limit                                  | Check oscillator frequency with counter                                                                                                                                                                                                             |
|                                                                                          | R312 out of adjustment                                                               | Do tuning indicator adjustment (Paragraph 3-27)                                                                                                                                                                                                     |
|                                                                                          | Range capacitor(s) or digit resistor(s) drifted out of tolerance in analyzer section | Unsolder range capacitor(s) from P.C. board to measure value. Check the suspected resistor(s) by actuating proper pushbutton(s) and measure at analyzer P.C. board.                                                                                 |
| Nulling becomes excessively slow                                                         | Oscillator drifted up in frequency                                                   | Check frequency with counter                                                                                                                                                                                                                        |
|                                                                                          | Photocoupler U205 or U206 characteristic changed causing a high integrator voltage   | Do Phase Null Integrator Voltage Adjustment (Paragraph 3-26A). Check D.C. voltage at TP8 with respect to TP7. If voltage is greater than 6 volts, change R359 according to procedure described in 3-31-i. If new R359 $\leq 500$ ohms, change U206. |
| Not Nulling on some frequencies                                                          | Bad contact in pushbutton switch                                                     | Refer to Troubleshooting Paragraph 3-29-k                                                                                                                                                                                                           |

### 3-38. Multi-Lead Devices

Follow the instructions given below when replacing multi-lead components on the printed-circuit boards:

- a. Cut all leads to remove device from P.C. board. The pieces of the leads that remain can then be unsoldered from the board.

#### CAUTION

Be sure to hold each lead with needle-nose pliers when it is unsoldered. This is to prevent the possibility of a lead dropping through a hole and shorting traces below the board.

- b. Using Solder-Wick, remove remaining solder from component holes.
- c. When replacing a device, ensure that the length of its leads match the length of the leads on the device removed. Do not push the new device too far down into board as this may cause a short to the metal deck below. The clearance between the boards and the metal deck is 1/4 inch.

### 3-39. Potentiometers

The small black rectangular potentiometers are attached to the printed-circuit boards by three leads projecting from their lower surface in line with the numbers "1", "2", and "3" marked on top. To remove this type of potentiometer, proceed as follows:

- a. Carefully raise side of potentiometer opposite numbers until leads below are visible.
- b. Continue bending leads until there is sufficient clearance for tip of soldering iron.
- c. Unsolder potentiometer following instructions given in Paragraph 3-38.
- d. Install replacement component following reverse procedure.

### 3-40. Power Supply

The majority of the components on the power supply assembly may be replaced without removing the board from its location on the rear panel. However, if additional access is required proceed as follows:

- a. Remove bottom cover from Model 1700A and remove retaining screws securing power supply board to rear panel.
- b. Slide power supply board forward through bottom of instrument as far as wires attached to it will allow.

### 3-41. FREQUENCY MODULE REPAIR

#### 3-42. General

The following procedure details step by step instructions for disassembly and repair of the instrument's frequency module. It is recommended that this procedure be closely followed and performed only by personnel familiar with electronic equipment disassembly/assembly techniques.

#### 3-43. Removal/Replacement

#### CAUTION

Certain subassemblies in the instrument are secured with hardware which includes insulating washers. Note the location of these washers when disassembling the unit and replace them in the same locations on reassembly. Failure to observe this precaution will result in improper operation of the instrument.



- a. Remove top and bottom covers and place instrument on clean work surface.
- b. Remove four screws securing right side brace (side nearest power transformer) to front and rear panels.
- c. Remove three screws securing deck and switch bracket in the bottom channel of right side brace.
- d. Remove handle caps and two screws securing handle to right side brace.
- e. Remove two screws securing analyzer deck to rear panel.
- f. Remove two screws securing left side brace to rear panel.
- g. Pull back rear panel and slide out brown handle plate on right side brace.
- h. Remove screw (which was beneath brown handle plate) securing switch bracket to right side brace.
- i. Remove four screws securing power supply assembly to rear panel. Move power supply to allow access to oscillator deck screws.
- j. Remove two screws securing oscillator deck to center divider.
- k. Remove two screws securing switch bracket to center divider.
- l. Carefully withdraw oscillator portion of frequency module from instrument. Unsolder wires attached to assembly if complete removal is desired.

#### NOTE

The wires are color-coded for attachment to the numbered holes in the printed circuit board; black = 0, brown = 1, red = 2, orange = 3, yellow = 4, etc.

- m. Remove four nuts securing analyzer portion of frequency module to front panel. Slide assembly back for access and unsolder wires if complete removal is required.
- n. Replace analyzer and oscillator frequency module assemblies and reassemble instrument following reverse procedure.

#### NOTE

1. When replacing analyzer portion of frequency module, line up pushbuttons with openings in front panel.

2. When replacing oscillator portion of frequency module, line up pushbars vertically with the rear of the pushbars of the analyzer section. Ensure also that there is a .015 inch clearance between the analyzer and oscillator pushbars, with the pushbuttons in undepressed position. See Figure 3-2 for details.

### 3-44. Repair Instructions

#### CAUTION

Field repair of the frequency module is limited to replacement of defective RC components on the switch boards. Replacement of pushbutton switches is not recommended -- order a replacement switch board from the factory.

- a. Remove bus wires running between boards, using multi-lead component desoldering technique described in this section of the manual. (paragraph 3-38)
- b. Detach board containing defective components from switch bracket and replace component.
- c. Reassemble module, replacing bus wires removed in step a.



NOTE

1. Spacing between boards must be  $25/32$  inch (inside to inside dimension) to ensure proper alignment.
2. Boards must be perpendicular to switch mounting bracket.

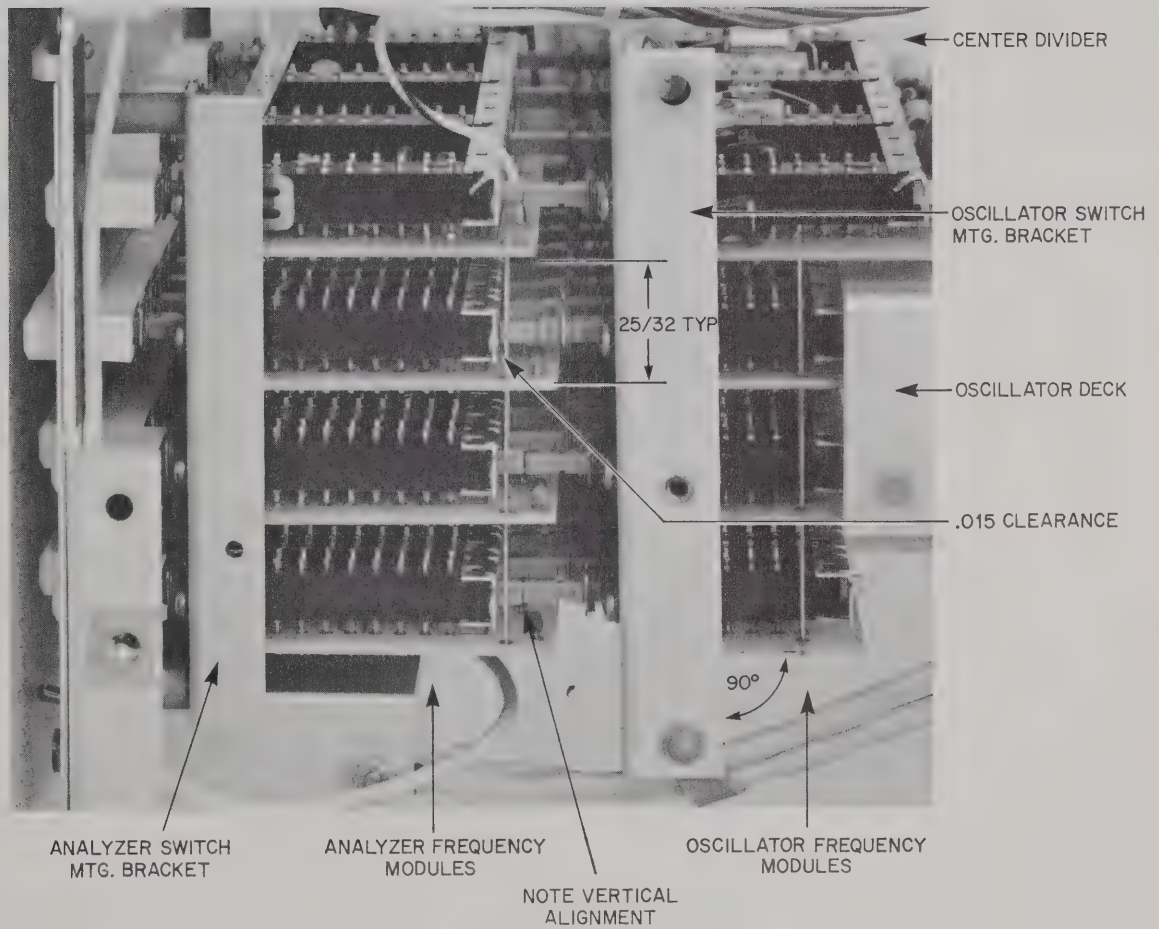


FIG. 3-2





## SECTION IV DIAGRAMS

### 4-1. INTRODUCTION

This section contains the circuit diagrams necessary for the operation and maintenance of the Model 1700A. Included are schematic diagrams and component location diagrams.

### 4-2. SCHEMATIC DIAGRAMS

The circuitry contained within each assembly is shown in the schematic diagrams. As an aid to isolating malfunctions, the diagrams also provide typical operating voltages and wave-forms.

### 4-3. COMPONENT LOCATION DIAGRAMS

The component location diagrams show the physical location of parts mounted on each assembly. Each part is identified by a reference designator, similarly identified on the schematic diagrams and in the parts list.



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# INTERMODULATION DISTORTION ANALYZER



*Measure total harmonic distortion and intermodulation distortion with one instrument —*

## THIS OPTION FITS RIGHT IN THE 1700B DISTORTION MEASUREMENT SYSTEM

- Measures Intermodulation Distortion down to .0025%.
- 70 dB Output Attenuator tracks 1700B Input Switch for rapid measurements, works when measuring THD, too.
- Available with automatic set level to cover between 10 dB steps for even faster operation.
- 4:1 and 1:1 ratios are switch selectable. No HF or LF adjustment required.
- Continuously adjustable LF:HF ratio lets you choose the ratio you want using the 1700B meter.
- Measures peak equivalent single-tone voltage or power.



## SOUND TECHNOLOGY

1400 DELL AVENUE  
CAMPBELL, CALIFORNIA 95008  
(408) 378-6540

# Specifications

## MEASUREMENT SECTION

All 1700B specifications and performance features are retained with the following additions.

**Intermodulation Distortion Ranges:** 0.01% to 100% full scale in 9 ranges.

**Residual Intermodulation Distortion and Noise:**  $< 0.0025\%$  with internal generators set at 4:1 for input signals greater than 0.3V (10 mw across  $8\Omega$ ).  $< 0.004\%$  for input signals 0.1V to 0.3V.

**Intermodulation Distortion Accuracy:**  $\pm 2\%$  full scale.

**Peak Equivalent Single Tone RMS Voltage Accuracy:**  $\pm 2\%$  full scale.

## GENERATOR SECTION

Output attenuator and vernier control the single tone sine-wave oscillator output as well as the intermodulation distortion generator output. All 1700B oscillator specifications apply except output level control is via the attenuator and output impedance is  $600\Omega$ .

**Output Voltage:** 1mV to 3V open circuit, peak equivalent single tone RMS.

**Output Attenuator:** 70 dB in 10 dB steps, accurate within  $\pm 0.1$  dB.

**Output Vernier:**  $> 10$  dB range, continuously adjustable.

**Output Impedance:**  $600\Omega \pm 1\%$ .

**Low Frequency Generator:** 50 or 60 Hz synchronized with power line. Total Harmonic Distortion  $< 0.1\%$ .

**High Frequency Generator:** 7 kHz  $\pm 1\%$ .

**LF/HF Ratio:** Switch selectable 4:1  $\pm 1\%$  or 1:1  $\pm 2\%$ . Continuously variable from 1:1 to  $> 100:1$  with HF amplitude control.

## GENERAL

**Weight:** Adds 5 lbs. to 1700B weight.

Data subject to change without notice.



## CONTENTS

| Section |                                                                                    | Page |
|---------|------------------------------------------------------------------------------------|------|
| I       | OPERATION. . . . .                                                                 | 1-1  |
| 1-1.    | SCOPE OF SECTION . . . . .                                                         | 1-1  |
| 1-2.    | INTRODUCTION . . . . .                                                             | 1-1  |
| 1-3.    | INPUT POWER REQUIREMENTS . . . . .                                                 | 1-1  |
| 1-4.    | POWER CABLE. . . . .                                                               | 1-1  |
| 1-5.    | CONTROLS AND INDICATORS. . . . .                                                   | 1-1  |
| 1-6.    | TEST SETUP . . . . .                                                               | 1-3  |
|         | 1-7. Power Connections. . . . .                                                    | 1-3  |
|         | 1-8. Ground Connections . . . . .                                                  | 1-3  |
|         | 1-9. Signal Connections . . . . .                                                  | 1-3  |
| 1-10    | OPERATING PROCEDURES . . . . .                                                     | 1-5  |
|         | 1-11. Test Connections . . . . .                                                   | 1-6  |
|         | 1-12. Meter Zero Mechanical Adjustment . . . . .                                   | 1-6  |
|         | 1-13. Distortion Measurement . . . . .                                             | 1-6  |
|         | 1-14. Distortion Measurement with External Oscillator. . . . .                     | 1-7  |
|         | 1-15. AC Voltage/Power Measurement. . . . .                                        | 1-7  |
|         | 1-16. AC Voltage Measurement-Extended Range. . . . .                               | 1-8  |
|         | 1-17. Voltage Ratio Measurement. . . . .                                           | 1-8  |
| 1-18.   | AUDIO MEASUREMENTS . . . . .                                                       | 1-9  |
|         | 1-19. Maximum Power Output at Rated Total Harmonic<br>Distortion at 1 kHz. . . . . | 1-9  |
|         | 1-20. Power Bandwidth. . . . .                                                     | 1-9  |
|         | 1-21. Hum and Noise/Signal-to-Noise Ratio. . . . .                                 | 1-10 |
| II      | PRINCIPLES OF OPERATION. . . . .                                                   | 2-1  |
| 2-1.    | INTRODUCTION . . . . .                                                             | 2-1  |
| 2-2.    | DISTORTION ANALYZER. . . . .                                                       | 2-1  |
|         | 2-3. General Description. . . . .                                                  | 2-2  |
|         | 2-4. Buffer Amplifier . . . . .                                                    | 2-2  |
|         | 2-5. Overload Detector. . . . .                                                    | 2-2  |
|         | 2-6. Notch Filter . . . . .                                                        | 2-2  |
|         | 2-7. Distortion Amplifier and Attenuator. . . . .                                  | 2-2  |
|         | 2-8. Amplitude Null Control . . . . .                                              | 2-2  |
|         | 2-9. Phase Null Control . . . . .                                                  | 2-3  |
|         | 2-10. Sum-Point Buffer . . . . .                                                   | 2-3  |
|         | 2-11. Tuning Indicator . . . . .                                                   | 2-3  |
|         | 2-12. Filters. . . . .                                                             | 2-4  |
|         | 2-13. Function Switches. . . . .                                                   | 2-4  |
|         | 2-14. AC Meter . . . . .                                                           | 2-4  |
| 2-15.   | OSCILLATOR . . . . .                                                               | 2-4  |
|         | 2-16. General Description. . . . .                                                 | 2-4  |
|         | 2-17. Oscillator Circuit . . . . .                                                 | 2-4  |
|         | 2-18. Amplitude Control. . . . .                                                   | 2-4  |
| 2-19.   | POWER SUPPLY . . . . .                                                             | 2-6  |
|         | 2-20. General Description. . . . .                                                 | 2-6  |
|         | 2-21. Input Circuit. . . . .                                                       | 2-6  |
|         | 2-22. + 15 Vdc Supply. . . . .                                                     | 2-6  |
|         | 2-23. - 15 Vdc Supply. . . . .                                                     | 2-7  |

# CONTENTS, Continued

| Section |                                                              | Page |
|---------|--------------------------------------------------------------|------|
| III     | MAINTENANCE. . . . .                                         | 3-1  |
| 3-1.    | INTRODUCTION . . . . .                                       | 3-1  |
| 3-2.    | TEST EQUIPMENT . . . . .                                     | 3-1  |
| 3-3.    | PERFORMANCE CHECK. . . . .                                   | 3-1  |
| 3-4.    | General Information. . . . .                                 | 3-1  |
| 3-5.    | Overall System Check . . . . .                               | 3-1  |
| 3-6.    | Distortion Test. . . . .                                     | 3-1  |
| 3-7.    | Circuit Common Isolation Check . . . . .                     | 3-3  |
| 3-8.    | Oscillator Check . . . . .                                   | 3-3  |
| 3-9.    | Frequency Test . . . . .                                     | 3-4  |
| 3-10.   | Distortion Test. . . . .                                     | 3-4  |
| 3-11.   | Distortion Analyzer Check. . . . .                           | 3-4  |
| 3-12.   | dB Volts Test. . . . .                                       | 3-4  |
| 3-13.   | Volts Power Test . . . . .                                   | 3-5  |
| 3-14.   | Filters Test . . . . .                                       | 3-5  |
| 3-15.   | Residual Noise Test. . . . .                                 | 3-6  |
| 3-16.   | Common Mode Rejection Test . . . . .                         | 3-6  |
| 3-17.   | ADJUSTMENT AND CALIBRATION PROCEDURE . . . . .               | 3-6  |
| 3-18.   | OSCILLATOR SECTION . . . . .                                 | 3-7  |
| 3-19.   | +15 Volt Adjustment. . . . .                                 | 3-7  |
| 3-20.   | Photocell AC Voltage Adjustments . . . . .                   | 3-7  |
| 3-21.   | Oscillator Integrator Voltage Change Adjustment. . . . .     | 3-7  |
| 3-22.   | Oscillator Integrator Output and Adjustment. . . . .         | 3-7  |
| 3-23.   | Oscillator X1000 Frequency Range Adjustment. . . . .         | 3-8  |
| 3-24.   | ANALYZER SECTION . . . . .                                   | 3-8  |
| 3-25.   | Dc Zero Adjustment . . . . .                                 | 3-8  |
| 3-26.   | Null Adjustment. . . . .                                     | 3-8  |
| 3-26A.  | Phase Null Integrator Voltage Adjustment . . . . .           | 3-9  |
| 3-27.   | Tuning Indicator Adjustment. . . . .                         | 3-9a |
| 3-28.   | Calibration at 1 kHz . . . . .                               | 3-10 |
| 3-29.   | TROUBLESHOOTING. . . . .                                     | 3-10 |
| 3-30.   | SYMPTOM/CAUSE TABLE. . . . .                                 | 3-11 |
| 3-31.   | COMPONENT REPLACEMENT - CALIBRATION and ADJUSTMENT . . . . . | 3-11 |
| 3-32.   | REPLACEMENT and REPAIR . . . . .                             | 3-12 |
| 3-33.   | Special Precautions. . . . .                                 | 3-12 |
| 3-34.   | Contamination. . . . .                                       | 3-12 |
| 3-35.   | WIRING . . . . .                                             | 3-12 |
| 3-36.   | SOLDERING TECHNIQUES . . . . .                               | 3-12 |
| 3-37.   | COMPONENT REPLACEMENT. . . . .                               | 3-12 |
| 3-38.   | Multi-Lead Devices . . . . .                                 | 3-15 |
| 3-39.   | Potentiometers . . . . .                                     | 3-15 |
| 3-40.   | Power Supply . . . . .                                       | 3-15 |
| 3-41.   | FREQUENCY MODULE REPAIR. . . . .                             | 3-15 |
| 3-42.   | General. . . . .                                             | 3-15 |
| 3-43.   | Removal/Replacement. . . . .                                 | 3-15 |
| 3-44.   | Repair Instructions. . . . .                                 | 3-17 |
| IV.     | DIAGRAMS . . . . .                                           | 4-1  |
| 4-1.    | INTRODUCTION . . . . .                                       | 4-1  |
| 4-2.    | SCHEMATIC DIAGRAMS . . . . .                                 | 4-1  |
| 4-3.    | COMPONENT LOCATION DIAGRAMS. . . . .                         | 4-1  |
| V.      | SPARE PARTS. . . . .                                         | 5-1  |
| 5-1.    | INTRODUCTION . . . . .                                       | 5-1  |
| 5-2.    | ORDERING INFORMATION . . . . .                               | 5-1  |
| 5-3.    | PARTS LIST . . . . .                                         |      |

PRICE \$10.00

MODEL 1700B  
DISTORTION MEASUREMENT  
SYSTEM

SOUND TECHNOLOGY

SERIAL NO. \_\_\_\_\_

COPYRIGHT 1974  
SOUND TECHNOLOGY  
1400 Dell Avenue  
CAMPBELL, CALIFORNIA 95008  
U.S.A.  
(408-378-6540)  
\*Patents Pending  
January 1976





## 1700B Modification Notice

### 0-1 INTRODUCTION

The Sound Technology Model 1700B Distortion Measurement System, first introduced in January, 1976 incorporates two design refinements not found on the 1700A. These refinements consist of two momentary front panel switches; one which replaces the oscillator signal at the SIGNAL OUTPUT jack with a floating short, and another which allows the operator to monitor the oscillator output signal with either the AC Voltmeter or Distortion Analyzer.

The reader should be aware that the terms, "1700A" and "1700B" are interchangeable as used throughout this manual.

### 0-1 OPERATION

#### a. Signal Off Switch

When depressed, this switch replaces the front panel SIGNAL OUTPUT jack with a floating short circuit. This enables the user to make signal to noise ratio measurements without the necessity of disconnecting cables.

#### b. Analyzer Select Switch

When this switch is depressed, the INPUT connectors are temporarily isolated and instrument is now monitoring the signal that appears at the SIGNAL OUTPUT Jack. The user may select either volts/power or DISTORTION function pushbuttons and measure the oscillator output voltage or residual distortion.



## SECTION I GENERAL INFORMATION

### 1-1. INTRODUCTION

This supplement provides operating and service information for the Model 1700B Intermodulation Distortion (IMD) Analyzer Option 004. The information contained in the supplement pertains to the IMD option only. Consult the Model 1700B manual for additional information regarding primary power requirements, grounding details, and cabling instructions.

### 1-2. MEASUREMENT TECHNIQUE

The IMD option is based on the SMPTE (Society of Motion Picture and Television Engineers) method to measure IMD whereby a large 60-Hz signal is combined with a small 7 kHz signal in a four-to-one amplitude ratio. Passing this combined (composite) signal through a non-linear device results in the appearance of new frequencies above and below 7 kHz in multiples of 60 Hz. The effect of these new frequencies is amplitude modulation of the 7 kHz signal, which can be detected.

The component parts of the IMD option include a signal source and an IM analyzer. The signal source generates a low-frequency sinusoid and a high-frequency sinusoid that are mixed and fed to the input of the device under test. Level controls are provided so that the amplitude of the composite signal can be set to the desired level. The signal from the output of the device under test is then fed back to the analyzer circuits of the IMD meter. A high-pass filter removes the low frequency, leaving only the high frequency together with any possible low-frequency modulation. This signal is input to an envelope detector (or absolute value detector) resulting in only the rectified carrier with its amplitude varying at a low-frequency rate. A low-pass filter removes the carrier, leaving only the modulation products. The amount of these products is indicated on the meter in terms of percentage of the high-frequency signal passed through the high-pass filter.

### 1-3. IMD OPTION

This option adds IMD measurement capability to the Model 1700B Distortion Measurement System. It employs the IMD measurement technique described above and in addition provides the user with a number of unique operating features. These are detailed in the following paragraphs.

The IM signal source contains a 60 Hz low-frequency oscillator and a 7 kHz high-frequency oscillator. Controls on the front panel permit a rapid selection of a composite test signal having fixed low-frequency to high-frequency ratios of 4:1 or 1:1 plus a variable ratio of greater than 16:1 to 1:1. The amplitude of the test signal is controlled by an accurate 10 dB-per-step attenuator with a range of 70 dB and by a 10 dB vernier control. The amplitude of the composite test signal can be measured directly in peak equivalent rms single tone voltage or power. This parameter, specified by the Institute of High Fidelity for IMD measurements, is defined as the voltage or power level of a sine-wave signal having a peak value equal to the peak value of the composite IM test signal. The ability to make this measurement eliminates the need for meter reading conversion or matching oscilloscope waveforms.

The IMD option combines with the Model 1700B input circuits to provide the option with a differential input configuration. In operation, the IM analyzer is capable of measuring IMD at all power levels between one milliwatt and ten kilowatts across eight ohms, with a residual intermodulation distortion of less than .0025 percent (.004 percent at one milliwatt). Meter sensitivity ranges from 100 percent to .01 percent full scale. The analyzer can also measure the LF-to-HF voltage ratio of the IM test signal from (a) input to the device under test or (b) output from the device to the analyzer. When the analyzer is used with a Model 1700B fitted with Auto Set Level (Option 003) it is possible to perform IMD testing within the range of one milliwatt to ten kilowatts without adjusting the SET LEVEL control. This feature facilitates testing volume compressors/expanders and similar non-linear devices. Operation with the Auto Set Level option also permits the user to switch from Total Harmonic Distortion (THD) testing to IMD testing without having to make adjustments to compensate for the frequency response of the device under test.





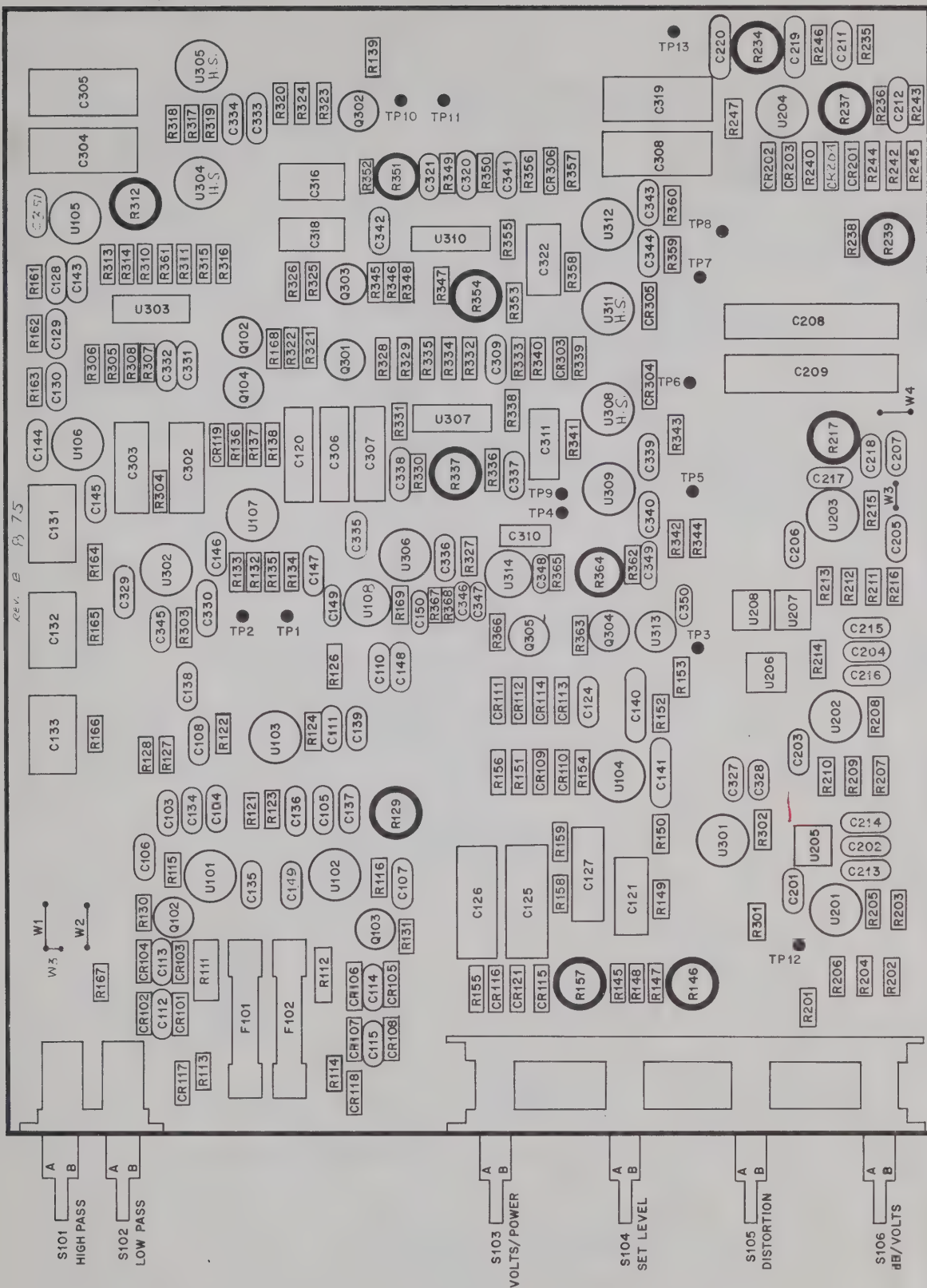


FIG. 4-1

SOUND TECHNOLOGY  
1400 DELL AVENUE  
CAMPBELL, CALIFORNIA 95008

ANALYZER BOARD

8-75



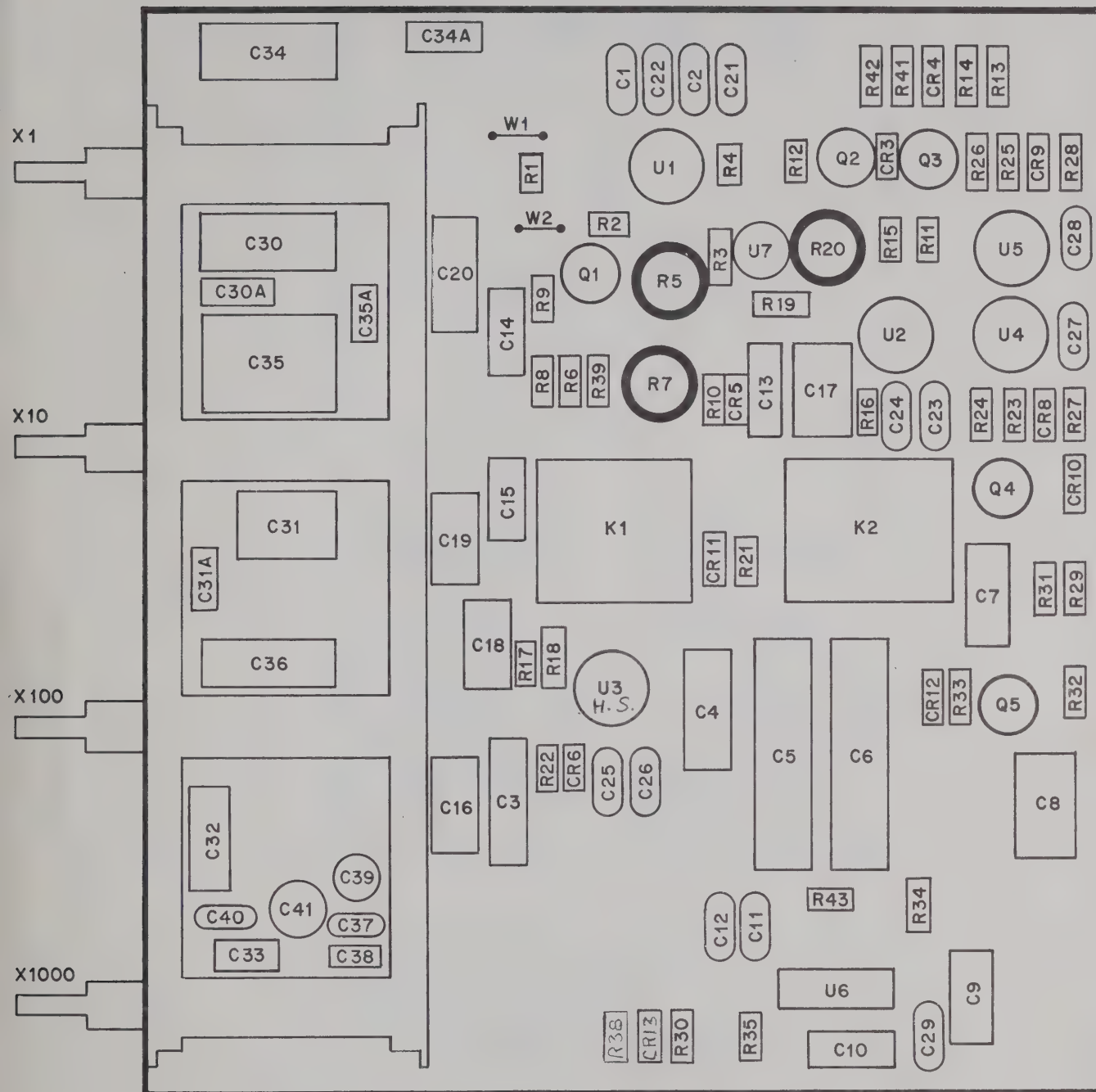


FIG. 4-3

SOUND TECHNOLOGY

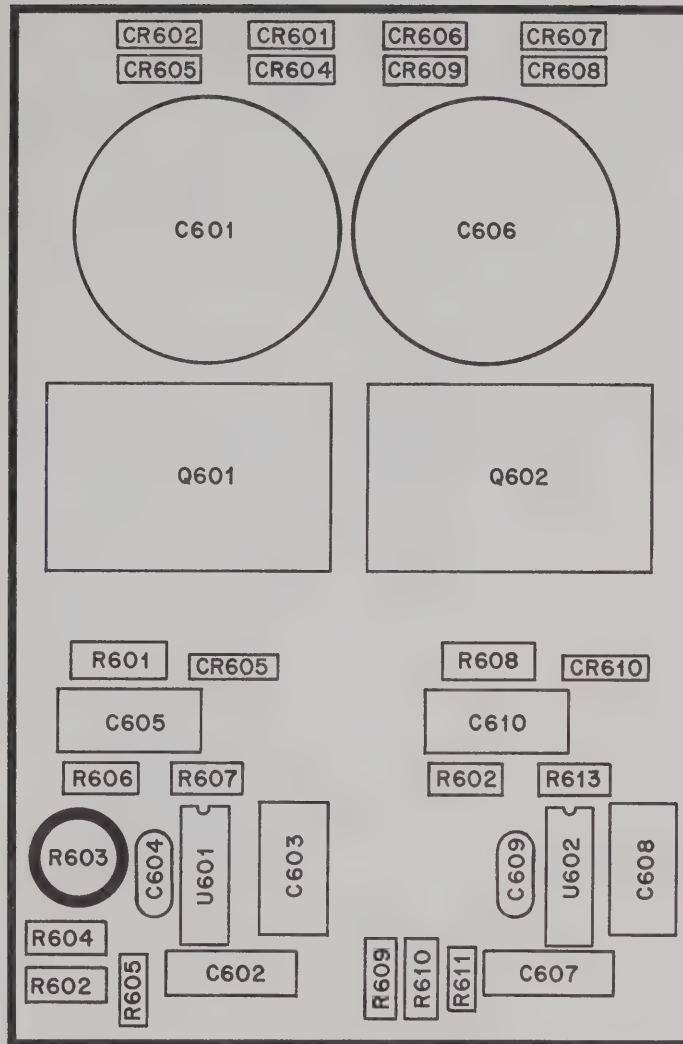
1400 DELL AVENUE  
CAMPBELL, CALIFORNIA 95008

OSCILLATOR BOARD

8-75







## SOUND TECHNOLOGY

1400 DELL AVENUE  
CAMPBELL, CALIFORNIA 95008

## POWER SUPPLY BOARD

12-11-74

FIG. 4-6



## SECTION V - SPARE PARTS

### 5-1. INTRODUCTION

This section contains information for ordering replacement parts, and provides the following details:

- a. The Sound Technology part number.
- b. Circuit diagram reference designator.
- c. General description of part.
- d. Total quantities used.

### 5-2. ORDERING INFORMATION

When ordering replacement parts, each part must be identified by a Sound Technology part number. To order a part include the following information:

- a. Instrument model number.
- b. Instrument serial number.
- c. Description of part.
- d. Function and location of part.

Address your order or inquiry to:

Sound Technology  
1400 Dell Avenue  
Campbell, California 95008

(408) 378-6540

## 5-3. PARTS LIST

## 1700A DISTORTION ANALYZER

## PURCHASED PARTS

| PART NO   | DESCRIPTION                      | QTY  | PART NO    | DESCRIPTION                      | QTY  |
|-----------|----------------------------------|------|------------|----------------------------------|------|
| 0300-0000 | DIODE-LED RED                    | 4.0  | 8005-0000  | BAIL-14 INCH                     | 1.0  |
|           | CR7, 120, 301, 302               |      | 8005-0002  | FEET-BAIL LEFT                   | 1.0  |
| 1400-0002 | RES-VAR 2.5K 10% 2W LOG CARB     | 1.0  | 8005-0003  | FEET-BAIL RIGHT                  | 1.0  |
|           | R44                              |      | 8005-0004  | FEET-RUBBER                      | 2.0  |
| 1400-0009 | RES-VAR 2K 10% 2W SPST SWITCH    | 1.0  | 8005-0005  | HANDLE-10 INCH                   | 2.0  |
|           | R125                             |      | 8020-0000  | BUSHING-NYLINER 1/4ID, 5/16OD    | 1.0  |
| 2020-0004 | CAP-FXD 1UF 10% 100V TUBULAR     | 1.0  | 8020-0001  | GROMMET-PLASTIC, Ø. 380D BLK     | 8.0  |
|           | C3                               |      | 8030-0000  | CLAMP-CABLE                      | 10.0 |
| 2020-0005 | CAP-FXD 1UF 10% 400V TUBULAR     | 2.0  | 8030-0002  | TIE-CABLE                        | 14.0 |
|           | C101, 102                        |      | 8030-0004  | MOUNT-CABLE TIE                  | 1.0  |
| 2040-0001 | CAP-FXD Ø. 01UF 2KV CERAMIC      | 2.0  | 8040-0001  | CLAMP-COMPONENT, 3/4" DIA        | 2.0  |
|           | C1, 2                            |      | 8050-0000  | LABEL-SERIAL TAG                 | 1.0  |
| 3000-0001 | SWITCH-TOGGLE                    | 1.0  | 8520-0004  | SCREW 4-40 X 1/4 POZI PAN HD     | 16.0 |
|           | S3                               |      | 8520-0006  | SCREW 4-40 X 3/8 POZI PAN HD     | 4.0  |
| 3005-0000 | SWITCH-SLIDE DPDT                | 2.0  | 8520-0104  | SCREW 4-40 X 1/4, 82 FLAT HD     | 6.0  |
|           | S5                               |      | 8520-0116  | SCREW 4-40 X 1", 82 FLAT HD      | 4.0  |
| 3005-0001 | SWITCH-SLIDE, LINE SELECT        | 1.0  | 8522-0001  | LOCKWASHER-EXT #4                | 38.0 |
|           | S5                               |      | 8526-0000  | WASHER-SHOULDER, #4X3/8LG, NYLON | 4.0  |
| 3100-0000 | CONNECTOR-BNC JACK, SHORT        | 1.0  | 8528-0001  | NUT-HEX 4-40 X 1/4               | 18.0 |
| 3100-0001 | CONNECTOR-BNC JACK, LONG         | 2.0  | 8540-0004  | SCREW 6-32 X 1/4 POZI PAN HD     | 18.0 |
| 3110-0000 | CONNECTOR-AC RECEPTACLE          | 1.0  | 8540-0006  | SCREW 6-32 X 3/8 POZI PAN HD     | 7.0  |
| 3110-0001 | CONNECTOR-BINDING POST, BROWN    | 4.0  | 8540-0008  | SCREW 6-32 X 1/2 POZI PAN HD     | 6.0  |
| 3200-0002 | TRANSFORMER-POWER 1700A          | 1.0  | 8540-0024  | SCREW 6-32 X 1 1/2 POZI PAN HD   | 4.0  |
|           | T1                               |      | 8540-0108  | SCREW 6-32 X 1/2, 82 FLAT HD     | 7.0  |
| 3200-0003 | END CAP, LARGE-XFMR 1400/1700    | 1.0  | 8540-0109  | SCREW 6-32X1/2, FLAT HD, LOCKING | 8.0  |
| 3320-0000 | METER-1MA, VRMS, PWR, DB         | 1.0  | 8540-0112  | SCREW 6-32 X 3/4, 82 FLAT HD     | 2.0  |
|           | M1                               |      | 8540-0206  | SCREW 6-32 X 3/8, 100 FLAT HD    | 16.0 |
| 3440-0000 | LAMP-NEON, AMBER                 | 1.0  | 8540-0208  | SCREW 6-32 X 1/2, 100 FLAT HD    | 8.0  |
|           | DS1                              |      | 8540-0406  | SCREW 6-32 X 3/8 HEX HD          | 1.0  |
| 3445-0001 | CONNECTOR-LAMP                   | 1.0  | 8542-0001  | LOCKWASHER-EXT #6                | 39.0 |
| 3445-0002 | RETAINING CLIP-LAMP              | 1.0  | 8544-0001  | FLAT WASHER #6                   | 4.0  |
| 3480-0002 | FUSE-1 AMP, 3AG                  | 3.0  | 8546-0000  | WASHER-SHOULDER, #6 FIBER        | 12.0 |
|           | F1-3                             |      | 8548-0001  | NUT-HEX 6-32 X 5/16              | 16.0 |
| 3485-0000 | FUSE HOLDER, 3AG                 | 1.0  | 8556-0001  | WASHER-FLAT, #8 NYLON            | 12.0 |
| 3485-0003 | FUSE HOLDER-DOUBLE, SCREW MOUNT  | 1.0  | 8566-0000  | WASHER-SHOULDER, #10 NYLON       | 12.0 |
| 7000-4000 | WIRE-INS, BLK, 22 AWG, UL1007    | 3.6  | 8582-0001  | LOCKWASHER-INT 5/16              | 4.0  |
| 7000-4001 | WIRE-INS, BRN, 22 AWG, UL1007    | 5.0  | 8582-0001  | LOCKWASHER-INT, 3/8              | 2.0  |
| 7000-4002 | WIRE-INS, RED, 22 AWG, UL1007    | 1.6  | 8586-0000  | WASHER-SHOULDER, 3/8ID, NYLON    | 4.0  |
| 7000-4003 | WIRE-INS, ORN, 22 AWG, UL1007    | 2.5  | 8610-0000  | CLIP NUT- 6-32                   | 24.0 |
| 7000-4004 | WIRE-INS, YEL, 22 AWG, UL1007    | 1.5  | 8640-0001  | DRIVE SCREW-#8 X 3/16, U TYPE    | 6.0  |
| 7000-4005 | WIRE-INS, GRN, 22 AWG, UL1007    | 3.0  | 8650-0004  | LUG, SOLDER-#4 INT LOCK          | 2.0  |
| 7000-4006 | WIRE-INS, BLU, 22 AWG, UL1007    | 2.0  | 8650-0006  | LUG, SOLDER-#6 INT LOCK          | 1.0  |
| 7000-4007 | WIRE-INS, VIO, 22 AWG, UL1007    | 2.0  | 8650-0015  | LUG-SOLDER, 5/16                 | 1.0  |
| 7000-4008 | WIRE-INS, GRA, 22 AWG, UL1007    | 3.5  | 8650-0016  | LUG, SOLDER-3/8                  | 2.0  |
| 7000-4009 | WIRE-INS, WHT, 22 AWG, UL1007    | 1.5  | 8700-0000  | SPACER-#6 X 3/8LG 1/4OD, BRS     | 2.0  |
| 7000-4011 | WIRE-INS, WHT/BRN, 22AWG, UL1007 | 3.0  | 8700-0001  | SPACER-#8 X 5/8LG 1/4OD, PLAST   | 4.0  |
| 7000-4012 | WIRE-INS, WHT/RED, 22AWG, UL1007 | 1.5  | 8722-0001  | TERMINAL-INSULATED, 6-32 THD     | 1.0  |
| 7000-4014 | WIRE-INS, WHT/YEL, 22AWG, UL1007 | 0.5  | 8725-0000  | TERMINAL STRIP-3 LUG             | 1.0  |
| 7004-0104 | WIRE-TWSTD PR, BRN & YEL, 22 AWG | 3.0  | 01700-1001 | SUBPANEL-FRONT 1700A             | 1.0  |
| 7004-0305 | WIRE-TWSTD PR, ORN & GRN, 22 AWG | 2.5  | 01700-1002 | PANEL REAR 1700A                 | 1.0  |
| 7005-0000 | WIRE-BUSS 20 AWG                 | 3.0  | 01700-1003 | SIDE BRACE-11 IN. 1700A          | 2.0  |
| 7050-0000 | CABLE-1 COND. SHIELDED, WHT      | 6.0  | 01700-1004 | SHIELD-POWER SWITCH              | 1.0  |
| 7050-0003 | CABLE-2 COND. SHLD. WHT, BLK/WHT | 3.5  | 01700-1005 | SUBSHIELD-POWER SWITCH           | 1.0  |
| 7100-0000 | CABLE ASSY-LINE CORD             | 1.0  | 01700-1006 | TRIM PLATE-RIGHT, WITH OSC       | 1.0  |
| 7600-0000 | CARTON-FOAM 1700A                | 1.0  | 01700-1008 | BRACKET-METER                    | 1.0  |
| 7700-0000 | ALUM-VINYL CLAD Ø. 061 THK       | 4.5  | 01700-1009 | DECK OSCILLATOR 1700A            | 1.0  |
| 7710-0001 | BAR-.16 X .187 X 16.71 LG. ALUM  | 2.0  | 01700-1010 | DECK ANALYZER 1700A              | 1.0  |
| 7777-0001 | OPERATION-CUT BEZEL MATL 1700A   | 2.0  | 01700-1011 | BRACKET-ROTARY SWITCH, REAR      | 1.0  |
| 7777-0003 | OPERATION-CUT SIDE BRACE 1700A   | 2.0  | 01700-1012 | DIVIDER 1700A                    | 1.0  |
| 7777-0005 | OPERATION-PAINT/SS, 01700-1006   | 1.0  | 01700-1013 | BRACKET-ROTARY SWITCH, FRONT     | 1.0  |
| 7777-0007 | OPERATION-PAINT 01700-1017       | 1.0  | 01700-1015 | BRACKET-OSC PB SWITCHES          | 1.0  |
| 7777-0008 | OPERATION-PAINT/SS 01700-1021    | 1.0  | 01700-1016 | BRACKET-PUSHBUTTON SWITCH        | 2.0  |
| 7777-0009 | OPERATION-PAINT/SS 01700-1022    | 1.0  | 01700-1017 | TRIM PLATE-LEFT                  | 1.0  |
| 7777-0024 | OPERATION-LCKNG MATL 8540-0109   | 8.0  | 01700-1021 | FRONT PANEL-LOWER 1700A          | 1.0  |
| 7780-0000 | EXTRUSION-ALUM BEZEL             | 8.7  | 01700-1022 | FRONT PANEL-UPPER 1700A          | 1.0  |
| 7780-0001 | EXTRUSION-ALUM SIDE BRACE        | 2.0  | 01700-1025 | SHIELD MULTIPLIER SWITCH 1700A   | 1.0  |
| 7900-0001 | MANUAL- 1700A                    | 1.0  | 01700-2003 | TRIM BAR 1700A                   | 2.0  |
| 8000-0000 | PUSHBUTTON-WHITE                 | 40.0 | 09990-1001 | BEZEL- 17 X 8 3/4 H              | 2.0  |
| 8000-0001 | KNOB-ROUND Ø. 7 DIA BEIGE        | 2.0  | 09990-1002 | DUST COVER-BOT, 17 X 12 DP       | 1.0  |
| 8000-0002 | KNOB-SKIRTED BEIGE               | 2.0  | 09990-1003 | DUST COVER-TOP, 17 X 12 DP       | 1.0  |
|           |                                  |      | 09990-1004 | PLATE-HANDLE, 12 INCH DP         | 2.0  |



# SUBASSEMBLY PARTS

| PART NO     | DESCRIPTION                      | QTY |
|-------------|----------------------------------|-----|
| 01700-30002 | ASSY-PC, OSC FREQ-MSD            | 1.0 |
| 01700-30003 | ASSY-PC, OSCILLATOR              | 1.0 |
| 01700-30004 | ASSY-PC, ANAL FREQ MSD           | 1.0 |
| 01700-30005 | ASSY-PC, ANAL MULTIPLIER         | 1.0 |
| 01700-30006 | ASSY-PC, ANALYZER                | 1.0 |
| 01700-30009 | ASSY-PC, PWR SUP, SYSTEM, SINGLE | 1.0 |
| 01700-30010 | ASSY-PC, ANAL FREQ 2ND DIGIT     | 1.0 |
| 01700-30011 | ASSY-PC, ANAL FREQ 3RD DIGIT     | 1.0 |
| 01700-30012 | ASSY-PC, OSC FREQ 2ND DIGIT      | 1.0 |
| 01700-30013 | ASSY-PC, OSC FREQ 3RD DIGIT      | 1.0 |
| 01700-30014 | INPUT SWITCH ASSEMBLY 1700A      | 1.0 |
| 01700-30015 | RATIO SWITCH ASSEMBLY 1700A      | 1.0 |

## 01700-30002 ASSY-PC, OSC FREQ-MSD

| PART NO    | DESCRIPTION                             | QTY |
|------------|-----------------------------------------|-----|
| 1005-1176  | RES-FXD 1.76K 0.25% 1/8W MF<br>R101,110 | 2.0 |
| 1005-1198  | RES-FXD 1.98K 0.25% 1/8W MF<br>R109,118 | 2.0 |
| 1005-1226  | RES-FXD 2.26K 0.25% 1/8W MF<br>R108,117 | 2.0 |
| 1005-1264  | RES-FXD 2.64K 0.25% 1/8W MF<br>R107,116 | 2.0 |
| 1005-1316  | RES-FXD 3.16K 0.25% 1/8W MF<br>R106,115 | 2.0 |
| 1005-1397  | RES-FXD 3.97K 0.25% 1/8W MF<br>R105,114 | 2.0 |
| 1005-1530  | RES-FXD 5.30K 0.25% 1/8W MF<br>R104,113 | 2.0 |
| 1005-1787  | RES-FXD 7.87K 0.25% 1/8W MF<br>R103,112 | 2.0 |
| 1005-2158  | RES-FXD 15.8K 0.25% 1/8W MF<br>R102,111 | 2.0 |
| 3015-0003  | SWITCH-PB, 10 STA-4P                    | 1.0 |
| 3150-0002  | SPACER-PUSHBUTTON SW, DOGBONE           | 4.0 |
| 01700-5002 | PC BOARD-OSC FREQUENCY                  | 1.0 |

## 01700-30003 ASSY-PC, OSCILLATOR

| PART NO   | DESCRIPTION                         | QTY  |
|-----------|-------------------------------------|------|
| 0000-0001 | TRANS 2N3644 PNP SI<br>Q2,3,5       | 3.0  |
| 0005-0000 | TRANS 2N3053 NPN SI<br>Q4           | 1.0  |
| 0025-0000 | TRANS-FET VCR2N N-CHAN<br>Q1        | 1.0  |
| 0100-0001 | IC-OP AMP 741<br>U2-5               | 4.0  |
| 0100-0007 | IC-OP AMP 2605 GRADE 2 RED<br>U1    | 1.0  |
| 0110-0000 | IC-TIMER 556<br>U6                  | 1.0  |
| 0200-0000 | DIODE-GEN 1N914A SI<br>CR3-6,8-13   | 10.0 |
| 0305-0002 | PHOTOCELL-LED GRADE 2 RED<br>U7     | 1.0  |
| 1005-2158 | RES-FXD 15.8K 0.25% 1/8W MF<br>R1,2 | 2.0  |
| 1015-0100 | RES-FXD 100 1% 1/8W MF<br>R19       | 1.0  |
| 1015-0316 | RES-FXD 316 1% 1/8W MF<br>R25       | 1.0  |
| 1015-1100 | RES-FXD 1K 1% 1/8W MF<br>R23        | 1.0  |
| 1015-1232 | RES-FXD 2.32K 1% 1/8W MF<br>R6      | 1.0  |
| 1015-1392 | RES-FXD 3.92K 1% 1/8W MF<br>R3      | 1.0  |
| 1015-1422 | RES-FXD 4.22K 1% 1/8W MF<br>R15     | 1.0  |
| 1015-1464 | RES-FXD 4.64K 1% 1/8W MF<br>R13     | 1.0  |
| 1015-2100 | RES-FXD 10K 1% 1/8W MF<br>R14       | 1.0  |

| PART NO   | DESCRIPTION                                 | QTY  |
|-----------|---------------------------------------------|------|
| 1015-2110 | RES-FXD 11K 1% 1/8W MF<br>R24,26            | 2.0  |
| 1015-2332 | RES-FXD 33.2K 1% 1/8W MF<br>R10             | 1.0  |
| 1015-2511 | RES-FXD 51.1K 1% 1/8W MF<br>R17             | 1.0  |
| 1015-4100 | RES-FXD 1M 1% 1/8W MF<br>R18                | 1.0  |
| 1100-0051 | RES-FXD 51 5% 1/4W<br>R8                    | 1.0  |
| 1100-0100 | RES-FXD 100 5% 1/4W<br>R11,12               | 2.0  |
| 1100-0560 | RES-FXD 560 5% 1/4W<br>R21                  | 1.0  |
| 1100-1100 | RES-FXD 1K 5% 1/4W<br>R9,38,41              | 3.0  |
| 1100-1330 | RES-FXD 3.3K 5% 1/4W<br>R29,30              | 2.0  |
| 1100-1680 | RES-FXD 6.8K 5% 1/4W<br>R31                 | 1.0  |
| 1100-1910 | RES-FXD 9.1K 5% 1/4W<br>R42                 | 1.0  |
| 1100-2100 | RES-FXD 10K 5% 1/4W<br>R16,22,43            | 4.0  |
| 1100-2120 | RES-FXD 12K 5% 1/4W<br>R27,28               | 2.0  |
| 1100-2510 | RES-FXD 51K 5% 1/4W<br>R33                  | 1.0  |
| 1100-3100 | RES-FXD 100K 5% 1/4W<br>R32                 | 1.0  |
| 1100-3150 | RES-FXD 150K 5% 1/4W<br>R39                 | 1.0  |
| 1100-3390 | RES-FXD 390K 5% 1/4W<br>R34                 | 1.0  |
| 1100-3820 | RES-FXD 820K 5% 1/4W<br>R35                 | 1.0  |
| 1410-0002 | RES-VAR 500 TRIMPOT CERMET<br>R5            | 1.0  |
| 1410-0004 | RES-VAR 5K TRIMPOT CERMET<br>R20            | 1.0  |
| 1410-0006 | RES-VAR 1M TRIMPOT CERMET<br>R7             | 1.0  |
| 2000-0005 | CAP-FXD 5PF 10% 500V MICA<br>C1             | 1.0  |
| 2000-0022 | CAP-FXD 22PF 5% 500V MICA<br>C40            | 1.0  |
| 2000-0033 | CAP-FXD 33PF 5% 500V MICA<br>C37            | 1.0  |
| 2000-0056 | CAP-FXD 56PF 5% 500V MICA<br>C2             | 1.0  |
| 2020-0000 | CAP-FXD 0.01UF 10% 100V MYLAR<br>C7,13      | 2.0  |
| 2020-0003 | CAP-FXD 0.1UF 10% 100V MYLAR<br>C16,17      | 2.0  |
| 2025-0000 | CAP-FXD 0.001UF 1% 33V PLYSTR<br>C33        | 1.0  |
| 2025-0003 | CAP-FXD 0.01UF 1% 33V PLYSTR<br>C32         | 1.0  |
| 2025-0006 | CAP-FXD 0.1UF 1% 33V PLYSTR<br>C31,35       | 2.0  |
| 2025-0009 | CAP-FXD 1.007UF 1% 100V FILM<br>C30,34      | 2.0  |
| 2025-0016 | CAP-FXD .0068UF 2.5% 63V PLYSTR<br>C30A,34A | 2.0  |
| 2025-0018 | CAP-FXD 0.0099UF 1% 63V PLYSTR<br>C36       | 1.0  |
| 2025-0019 | CAP-FXD 680PF 2.5% 63V PLYSTR<br>C31A,35A   | 2.0  |
| 2025-0023 | CAP-FXD 820PF 1% 63V PLYSTR<br>C38          | 1.0  |
| 2040-0000 | CAP-FXD 0.01UF 100V CERAMIC<br>C11,12,21-29 | 10.0 |
| 2100-0000 | CAP-FXD 4.7UF 10% 35V TANT<br>C9,10         | 2.0  |
| 2100-0001 | CAP-FXD 1UF 25V ELECT AL<br>C8,14,15,18     | 3.0  |
| 2100-0003 | CAP-FXD 10UF 25V ELECT AL<br>C3,19          | 2.0  |

| PART NO    | DESCRIPTION                           | QTY |
|------------|---------------------------------------|-----|
| 2100-0004  | CAP-FXD 35UF 25V ELECT AL C20         | 1.0 |
| 2100-0005  | CAP-FXD 50UF 25V ELECT AL C4          | 1.0 |
| 2100-0008  | CAP-FXD 390UF 12V ELECT AL C5,6       | 2.0 |
| 2100-0016  | CAP-FXD 1UF 35V ELECT TANT            | 1.0 |
| 2205-0004  | CAP-VAR 7-35PF TRIMMER CERAMIC C39,41 | 2.0 |
| 3015-0002  | SWITCH-PB, 4 STA(2 SPACE)-6P S7       | 1.0 |
| 3105-0000  | SOCKET-IC 8 PIN ROUND                 | 5.0 |
| 3105-0001  | SOCKET-IC 14 PIN DIP                  | 1.0 |
| 3150-0002  | SPACER-PUSHBUTTON SW, DOGBONE         | 4.0 |
| 3400-0000  | RELAY-2 FORM C K1,2                   | 2.0 |
| 3600-0000  | HEAT SINK-ROUND FINNED T05            | 1.0 |
| 7200-0001  | WIRE JUMPER-0.2 CTRS,PVC INSUL        | 2.0 |
| 8720-0000  | TERMINAL-BIFURCATED, SWAGE-IN         | 6.0 |
| 01700-5003 | PC BOARD-OSCILLATOR                   | 1.0 |

#### 01700-30004 ASSY-PC.

#### ANAL FREQ MSD

| PART NO   | DESCRIPTION                     | QTY |
|-----------|---------------------------------|-----|
| 1005-1176 | RES-FXD 1.76K 0.25% 1/8W MF R19 | 1.0 |
| 1005-1198 | RES-FXD 1.98K 0.25% 1/8W MF R27 | 1.0 |
| 1005-1226 | RES-FXD 2.26K 0.25% 1/8W MF R26 | 1.0 |
| 1005-1264 | RES-FXD 2.64K 0.25% 1/8W MF R25 | 1.0 |
| 1005-1316 | RES-FXD 3.16K 0.25% 1/8W MF R24 | 1.0 |
| 1005-1397 | RES-FXD 3.97K 0.25% 1/8W MF R23 | 1.0 |
| 1005-1530 | RES-FXD 5.30K 0.25% 1/8W MF R22 | 1.0 |
| 1005-1787 | RES-FXD 7.87K 0.25% 1/8W MF R21 | 1.0 |
| 1005-1887 | RES-FXD 8.87K 0.25% 1/8W MF R1  | 1.0 |
| 1005-2100 | RES-FXD 10K 0.25% 1/8W MF R9    | 1.0 |
| 1005-2114 | RES-FXD 11.4K 0.25% 1/8W MF R8  | 1.0 |
| 1005-2133 | RES-FXD 13.3K 0.25% 1/8W MF R7  | 1.0 |
| 1005-2158 | RES-FXD 15.8K 0.25% 1/8W MF R20 | 1.0 |
| 1005-2160 | RES-FXD 16.0K 0.25% 1/8W MF R6  | 1.0 |
| 1005-2200 | RES-FXD 20K 0.25% 1/8W MF R5    | 1.0 |
| 1005-2267 | RES-FXD 26.7K 0.25% 1/8W MF R4  | 1.0 |
| 1005-2397 | RES-FXD 39.7K 0.25% 1/8W MF R3  | 1.0 |
| 1005-2796 | RES-FXD 79.6K 0.25% 1/8W MF R2  | 1.0 |
| 1100-0680 | RES-FXD 680 5% 1/4W R10         | 1.0 |
| 1100-0750 | RES-FXD 750 5% 1/4W R18         | 1.0 |
| 1100-0910 | RES-FXD 910 5% 1/4W R17         | 1.0 |
| 1100-1120 | RES-FXD 1.2K 5% 1/4W R16        | 1.0 |
| 1100-1150 | RES-FXD 1.5K 5% 1/4W R15        | 1.0 |
| 1100-1200 | RES-FXD 2K 5% 1/4W R14          | 1.0 |
| 1100-1270 | RES-FXD 2.7K 5% 1/4W R13        | 1.0 |
| 1100-1470 | RES-FXD 4.7K 5% 1/4W R12        | 1.0 |

| PART NO    | DESCRIPTION                   | QTY |
|------------|-------------------------------|-----|
| 1100-2100  | RES-FXD 10K 5% 1/4W R11       | 1.0 |
| 3015-0004  | SWITCH-PB, 10 STA-6P S9       | 1.0 |
| 3150-0002  | SPACER-PUSHBUTTON SW, DOGBONE | 4.0 |
| 01700-5004 | PC BOARD-ANALYZER FREQUENCY   | 1.0 |

#### 01700-30005 ASSY-PC.

#### ANAL MULTIPLIER

| PART NO    | DESCRIPTION                       | QTY |
|------------|-----------------------------------|-----|
| 2025-0001  | CAP-FXD 0.002UF 1% 33V PLYSTR C3  | 1.0 |
| 2025-0002  | CAP-FXD 0.0082UF 1% 33V PLYSTR C8 | 1.0 |
| 2025-0004  | CAP-FXD 0.02UF 1% 33V PLYSTR C4   | 1.0 |
| 2025-0005  | CAP-FXD 0.082UF 1% 33V PLYSTR C9  | 1.0 |
| 2025-0007  | CAP-FXD 0.2UF 1% 100V FILM C5     | 1.0 |
| 2025-0008  | CAP-FXD 0.82UF 1% 100V FILM C10   | 1.0 |
| 2025-0020  | CAP-FXD 200PF 1% 63V PLYSTR C2    | 1.0 |
| 2025-0021  | CAP-FXD 220PF 1% 63V PLYSTR C6    | 1.0 |
| 2025-0022  | CAP-FXD 560PF 1% 63V PLYSTR C7    | 1.0 |
| 2205-0000  | CAP-VAR 4.5-20PF TRIMMER CER C1   | 1.0 |
| 3015-0002  | SWITCH-PB, 4 STA(2 SPACE)-6P S8   | 1.0 |
| 3150-0002  | SPACER-PUSHBUTTON SW, DOGBONE     | 4.0 |
| 01700-5005 | PC BOARD-MULTIPLIER               | 1.0 |

#### 01700-30006 ASSY-PC.

#### ANALYZER

| PART NO   | DESCRIPTION                                                   | QTY  |
|-----------|---------------------------------------------------------------|------|
| 0000-0001 | TRANS 2N3644 PNP SI Q301,303,305                              | 3.0  |
| 0005-0000 | TRANS 2N3053 NPN SI Q102,302,304                              | 3.0  |
| 0005-0002 | TRANS 2N4996 NPN SI Q104                                      | 1.0  |
| 0020-0000 | TRANS-FET MEM511C MOS P-CHAN Q102,103                         | 2.0  |
| 0100-0000 | IC-COMPARATOR 710 U107,302,306                                | 3.0  |
| 0100-0001 | IC-OP AMP 741 U106,304,305,308,309,311-314                    | 8.0  |
| 0100-0002 | IC-BAL MOD/DEM0D 1496 U303,307,310                            | 3.0  |
| 0100-0003 | IC-OP AMP 2625 U104,204                                       | 2.0  |
| 0100-0006 | IC-OP AMP 2605 GRADE 1 BROWN U103                             | 1.0  |
| 0100-0008 | IC-OP AMP 2605 GRADE 3 ORANGE U101,102                        | 2.0  |
| 0100-0009 | IC-OP AMP 2605 GRADE 4 YELLOW U201,202                        | 2.0  |
| 0100-0010 | IC-OP AMP 2605 GRADE 5 GREEN U203,301                         | 2.0  |
| 0100-0014 | IC-OP AMP 2605 GRADE 6 BLUE U108                              | 1.0  |
| 0100-0016 | OP-AMP 301C U105                                              | 1.0  |
| 0200-0000 | DIODE-GEN 1N914A SI CR101-108,109-116,119,121,201-206,303,306 | 24.0 |
| 0205-0000 | DIODE-ZENER 1N755 7.5V CR117,118                              | 2.0  |
| 0205-0001 | DIODE-ZENER 1N963A 12V CR304,305                              | 2.0  |
| 0305-0001 | PHOTOCELL-LED GRADE 1 BROWN U205                              | 1.0  |



| PART NO   | DESCRIPTION                                                        | QTY | PART NO   | DESCRIPTION                                                                                   | QTY  |
|-----------|--------------------------------------------------------------------|-----|-----------|-----------------------------------------------------------------------------------------------|------|
| 0305-0004 | PHOTOCELL-LED GRADE 4 YELLOW<br>U206                               | 1.0 | 1100-1510 | RES-FXD 5.1K 5% 1/4W<br>R113, 114, 137, 350                                                   | 4.0  |
| 0305-0006 | PHOTOCELL-LED GRADE 6 BLUE<br>U207, 208                            | 2.0 | 1100-2100 | RES-FXD 10K 5% 1/4W<br>R168, 307, 308, 317, 319, 330, 331, 347, 348,<br>358, 363, 367 367     | 12.0 |
| 1005-1422 | RES-FXD 4.22K 0.25% 1/8W MF<br>R115, 116                           | 2.0 | 1100-2150 | RES-FXD 15K 5% 1/4W<br>R242, 244                                                              | 2.0  |
| 1005-2100 | RES-FXD 10K 0.25% 1/8W MF<br>R121-124                              | 4.0 | 1100-2180 | RES-FXD 18K 5% 1/4W<br>R213                                                                   | 1.0  |
| 1005-2158 | RES-FXD 15.8K 0.25% 1/8W MF<br>R209                                | 1.0 | 1100-2270 | RES-FXD 27K 5% 1/4W<br>R341                                                                   | 1.0  |
| 1005-2796 | RES-FXD 79.6K 0.25% 1/8W MF<br>R206                                | 1.0 | 1100-2330 | RES-FXD 33K 5% 1/4W<br>R210                                                                   | 1.0  |
| 1015-0010 | RES-FXD 10 1% 1/8W MF<br>R158, 159                                 | 2.0 | 1100-3100 | RES-FXD 100K 5% 1/4W<br>R130, 131, 138, 301, 302                                              | 5.0  |
| 1015-0021 | RES-FXD 21.5 1% 1/8W MF<br>R147, 236, 238                          | 3.0 | 1100-4100 | RES-FXD 1M 5% 1/4W<br>R149, 154, 169                                                          | 3.0  |
| 1015-0056 | RES-FXD 56.2 1% 1/8W MF<br>R240                                    | 1.0 | 1200-2000 | RES-FXD 500 3W WW<br>R111, 112                                                                | 2.0  |
| 1015-0090 | RES-FXD 90.9 1% 1/8W MF<br>R148                                    | 1.0 | 1410-0001 | RES-VAR 100 TRIMPOT CERMET<br>R157, 239, 312, 337, 359                                        | 5.0  |
| 1015-0316 | RES-FXD 316 1% 1/8W MF<br>R362                                     | 1.0 | 1410-0003 | RES-VAR 1K TRIMPOT CERMET<br>R146, 237                                                        | 2.0  |
| 1015-0402 | RES-FXD 402 1% 1/8W MF<br>R323                                     | 1.0 | 1410-0005 | RES-VAR 100K TRIMPOT CERMET<br>R129, 217, 234                                                 | 3.0  |
| 1015-1100 | RES-FXD 1K 1% 1/8W MF<br>R126, 128, 201, 325, 332, 349             | 6.0 | 1410-0007 | RES-VAR 20K TRIMPOT CERMET<br>R351                                                            | 1.0  |
| 1015-1121 | RES-FXD 1.21K 1% 1/8W MF<br>R202, 326                              | 2.0 | 1411-0000 | RES-VAR 1K TRIMPOT WIREWOUND<br>R364                                                          | 1.0  |
| 1015-1200 | RES-FXD 2K 1% 1/8W MF<br>R235, 324                                 | 2.0 | 2000-0010 | CAP-FXD 10PF 5% 500V MICA<br>C103, 106, 108, 111, 201, 205, 206, 309,                         | 8.0  |
| 1015-1280 | RES-FXD 2.8K 1% 1/8W MF<br>R135, 165                               | 2.0 | 2000-0012 | CAP-FXD 12PF 5% 500V MICA<br>C351                                                             | 1.0  |
| 1015-1392 | RES-FXD 3.92K 1% 1/8W MF<br>R311, 313, 336, 338, 353, 355          | 6.0 | 2000-0022 | CAP-FXD 22PF 5% 500V MICA<br>C203                                                             | 1.0  |
| 1015-1464 | RES-FXD 4.64K 1% 1/8W MF<br>R132                                   | 1.0 | 2000-0027 | CAP-FXD 27PF 5% 500V MICA<br>C149, 187                                                        | 2.0  |
| 1015-1715 | RES-FXD 7.15K 1% 1/8W MF<br>R166, 314, 335, 352                    | 4.0 | 2000-0047 | CAP-FXD 47PF 5% 500V MICA<br>C320                                                             | 1.0  |
| 1015-1750 | RES-FXD 7.5K 1% 1/8W MF<br>R133, 161-163                           | 4.0 | 2000-0051 | CAP-FXD 51PF 5% 500V MICA<br>C128                                                             | 1.0  |
| 1015-1909 | RES-FXD 9.09K 1% 1/8W MF<br>R127, 212                              | 2.0 | 2000-0056 | CAP-FXD 56PF 5% 500V MICA<br>C104, 105, 110, 124, 148, 202, 204, 207, 212                     | 9.0  |
| 1015-2100 | RES-FXD 10K 1% 1/8W MF<br>R145, 204, 205, 207, 208, 216, 342       | 7.0 | 2000-0082 | CAP-FXD 82PF 5% 500V MICA<br>C211                                                             | 1.0  |
| 1015-2110 | RES-FXD 11K 1% 1/8W MF<br>R134                                     | 1.0 | 2000-0100 | CAP-FXD 100PF 5% 500V MICA<br>C345, 346                                                       | 2.0  |
| 1015-2475 | RES-FXD 47.5K 1% 1/8W MF<br>R215                                   | 1.0 | 2000-0270 | CAP-FXD 270PF 5% 500V MICA<br>C112-115                                                        | 4.0  |
| 1015-2499 | RES-FXD 49.9K 1% 1/8W MF<br>R164                                   | 1.0 | 2000-0360 | CAP-FXD 360PF 5% 500V MICA<br>C130                                                            | 1.0  |
| 1100-0010 | RES-FXD 10 5% 1/4W<br>R343, 368                                    | 2.0 | 2000-0910 | CAP-FXD 910PF 5% 500V MICA<br>C129                                                            | 1.0  |
| 1100-0022 | RES-FXD 22 5% 1/4W<br>R156                                         | 1.0 | 2020-0001 | CAP-FXD 0.022UF 10% 100V MYLAR<br>C311, 322                                                   | 2.0  |
| 1100-0100 | RES-FXD 100 5% 1/4W<br>R150, 152, 153, 203, 303, 304, 327          | 7.0 | 2020-0003 | CAP-FXD 0.1UF 10% 100V MYLAR<br>C121                                                          | 1.0  |
| 1100-0180 | RES-FXD 180 5% 1/4W<br>R155, 365                                   | 2.0 | 2025-0010 | CAP-FXD 0.039UF 2.5% 33V PLYSTR<br>C131-133                                                   | 3.0  |
| 1100-0270 | RES-FXD 270 5% 1/4W<br>R318                                        | 1.0 | 2040-0000 | CAP-FXD 0.01UF 100V CERAMIC<br>C134-139, 142-147, 213-220, 321, 327,<br>328, 331-334, 337-344 | 39.0 |
| 1100-0330 | RES-FXD 330 5% 1/4W<br>R246, 247, 320,                             | 3.0 | 2040-0002 | CAP-FXD 0.1UF 25V CERAMIC<br>C140, 141, 219, 220, 325, 326, 329, 330                          | 8.0  |
| 1100-0510 | RES-FXD 510 5% 1/4W<br>R139, 366                                   | 2.0 | 2100-0001 | CAP-FXD 1UF 25V ELECT AL<br>C310                                                              | 1.0  |
| 1100-1100 | RES-FXD 1K 5% 1/4W<br>R136, 151, 167, 243, 245, 310, 316, 344, 360 | 9.0 | 2100-0004 | CAP-FXD 35UF 25V ELECT AL<br>C120, 127, 302, 303, 306, 307, 316, 318                          | 8.0  |
| 1100-1150 | RES-FXD 1.5K 5% 1/4W<br>R214, 333, 334                             | 3.0 | 2100-0006 | CAP-FXD 100UF 25V ELECT AL<br>C125, 126, 304, 305, 308, 319                                   | 6.0  |
| 1100-1200 | RES-FXD 2K 5% 1/4W<br>R339, 357, 361                               | 3.0 | 2100-0007 | CAP-FXD 200UF 25V ELECT AL<br>C208, 209                                                       | 2.0  |
| 1100-1220 | RES-FXD 2.2K 5% 1/4W<br>R211, 305, 306, 328, 329, 345, 346, 359    | 8.0 | 3015-0000 | SWITCH-PB, 2 STA-2P, P-P<br>S101, 102                                                         | 1.0  |
| 1100-1270 | RES-FXD 2.7K 5% 1/4W<br>R322                                       | 1.0 | 3015-0001 | SWITCH-PB 4 STA(1 SPACE)-2P<br>S103-106                                                       | 1.0  |
| 1100-1330 | RES-FXD 3.3K 5% 1/4W<br>R321                                       | 1.0 | 3105-0000 | SOCKET-IC 8 PIN ROUND                                                                         | 23.0 |
| 1100-1390 | RES-FXD 3.9K 5% 1/4W<br>R315, 340, 356                             | 3.0 | 3105-0001 | SOCKET-IC 14 PIN DIP                                                                          | 3.0  |



| PART NO    | DESCRIPTION                    | QTY |
|------------|--------------------------------|-----|
| 3150-0002  | SPACER-PUSHBUTTON SW, DOGBONE  | 8.0 |
| 3480-0000  | FUSE-1/8 AMP, 3AG              | 2.0 |
| 3485-0001  | CLIP-FUSE, PC                  | 4.0 |
| 3600-0000  | HEAT SINK-ROUND FINNED T05     | 4.0 |
| 7200-0000  | WIRE JUMPER-0.4 CTRS,PVC INSUL | 2.0 |
| 7200-0001  | WIRE JUMPER-0.2 CTRS,PVC INSUL | 2.0 |
| 8702-0000  | STANDOFF- 4-40X3/4, 1/4 HEX    | 2.0 |
| 8720-0000  | TERMINAL-BIFURCATED, SWAGE-IN  | 6.0 |
| 01700-1024 | SHIELD-BUFFER 1700A            | 1.0 |
| 01700-5006 | PC BOARD-ANALYZER              | 1.0 |

# 01700-30009 ASSY-PC, PWR SUP

| PART NO    | DESCRIPTION                                   | QTY  |
|------------|-----------------------------------------------|------|
| 0005-0001  | TRANS-POWER 2N3055 NPN SI<br>Q601,602         | 2.0  |
| 0100-0012  | IC-REGULATOR 723, DIP 14 PIN<br>U1,2          | 2.0  |
| 0200-0001  | DIODE-RECT 1N4003 SI<br>CR601-610             | 10.0 |
| 1015-1422  | RES-FXD 4.22K 1% 1/8W MF<br>R604              | 1.0  |
| 1015-1464  | RES-FXD 4.64K 1% 1/8W MF<br>R602              | 1.0  |
| 1015-1715  | RES-FXD 7.15K 1% 1/8W MF<br>R610              | 1.0  |
| 1015-1787  | RES-FXD 7.87K 1% 1/8W MF<br>R609              | 1.0  |
| 1100-1150  | RES-FXD 1.5K 5% 1/4W<br>R606,612              | 2.0  |
| 1100-1220  | RES-FXD 2.2K 5% 1/4W<br>R605                  | 1.0  |
| 1100-1390  | RES-FXD 3.9K 5% 1/4W<br>R611                  | 1.0  |
| 1100-2150  | RES-FXD 15K 5% 1/4W<br>R607,613               | 2.0  |
| 1110-4000  | RES-FXD 9.1 OHM, 5%, 1W<br>R608               | 1.0  |
| 1200-1000  | RES-FXD 5 2W WW<br>R601                       | 1.0  |
| 1410-0002  | RES-VAR 500 TRIMPOT CERMET<br>R603            | 1.0  |
| 2000-0100  | CAP-FXD 100PF 5% 500V MICA<br>R604,609        | 2.0  |
| 2020-0000  | CAP-FXD 0.01UF 10% 100V MYLAR<br>C602,607     | 2.0  |
| 2100-0004  | CAP-FXD 35UF 25V ELECT AL<br>C603,605,608,610 | 3.0  |
| 2100-0006  | CAP-FXD 100UF 25V ELECT AL<br>C610            | 1.0  |
| 2100-0009  | CAP-FXD 1800-2500UF 40-50V EL<br>C606         | 1.0  |
| 2100-0010  | CAP-FXD 3000-4200UF 40-50V EL<br>C601         | 1.0  |
| 3150-0005  | INSULATOR- T0-3 TRANSISTOR                    | 2.0  |
| 3150-0007  | INSULATOR-TRANS, T0-3 NYLON                   | 2.0  |
| 3600-0001  | HEAT SINK-T03                                 | 2.0  |
| 8540-0000  | SCREW 6-32 X 1/2 POZI PAN HD                  | 4.0  |
| 8542-0001  | LOCKWASHER-EXT #6                             | 8.0  |
| 8548-0001  | NUT-HEX 6-32 X 5/16                           | 4.0  |
| 8720-0000  | TERMINAL-BIFURCATED, SWAGE-IN                 | 4.0  |
| 01700-5007 | PC BOARD-POWER SUPPLY                         | 1.0  |

# 01700-30010 ASSY-PC, ANAL FREQ 2ND DIGIT

| PART NO   | DESCRIPTION                        | QTY |
|-----------|------------------------------------|-----|
| 1005-2174 | RES-FXD 17.4K 0.25% 1/8W MF<br>R54 | 1.0 |
| 1005-2196 | RES-FXD 19.6K 0.25% 1/8W MF<br>R53 | 1.0 |
| 1005-2226 | RES-FXD 22.6K 0.25% 1/8W MF<br>R52 | 1.0 |
| 1005-2887 | RES-FXD 88.7K 0.25% 1/8W MF<br>R36 | 1.0 |
| 1005-3100 | RES-FXD 100K 0.25% 1/8W MF<br>R35  | 1.0 |

| PART NO    | DESCRIPTION                       | QTY |
|------------|-----------------------------------|-----|
| 1005-3115  | RES-FXD 115K 0.25% 1/8W MF<br>R34 | 1.0 |
| 1015-2261  | RES-FXD 26.1K 1% 1/8W MF<br>R51   | 1.0 |
| 1015-2316  | RES-FXD 31.6K 1% 1/8W MF<br>R50   | 1.0 |
| 1015-2392  | RES-FXD 39.2K 1% 1/8W MF<br>R49   | 1.0 |
| 1015-2523  | RES-FXD 52.3K 1% 1/8W MF<br>R48   | 1.0 |
| 1015-2787  | RES-FXD 78.7K 1% 1/8W MF<br>R47   | 1.0 |
| 1015-3133  | RES-FXD 133K 1% 1/8W MF<br>R33    | 1.0 |
| 1015-3158  | RES-FXD 158K 1% 1/8W MF<br>R32,46 | 2.0 |
| 1015-3200  | RES-FXD 200K 1% 1/8W MF<br>R31    | 1.0 |
| 1015-3267  | RES-FXD 267K 1% 1/8W MF<br>R30    | 1.0 |
| 1015-3402  | RES-FXD 402K 1% 1/8W MF<br>R29    | 1.0 |
| 1015-3806  | RES-FXD 806K 1% 1/8W MF<br>R28    | 1.0 |
| 1100-2100  | RES-FXD 10K 5% 1/4W<br>R45        | 1.0 |
| 1100-2120  | RES-FXD 12K 5% 1/4W<br>R44        | 1.0 |
| 1100-2150  | RES-FXD 15K 5% 1/4W<br>R43        | 1.0 |
| 1100-2160  | RES-FXD 16K 5% 1/4W<br>R42        | 1.0 |
| 1100-2180  | RES-FXD 18K 5% 1/4W<br>R41        | 1.0 |
| 1100-2220  | RES-FXD 22K 5% 1/4W<br>R40        | 1.0 |
| 1100-2330  | RES-FXD 33K 5% 1/4W<br>R39        | 1.0 |
| 1100-2510  | RES-FXD 51K 5% 1/4W<br>R38        | 1.0 |
| 1100-2820  | RES-FXD 82K 5% 1/4W<br>R37        | 1.0 |
| 3015-0004  | SWITCH-PB, 10 STA-6P<br>S10       | 1.0 |
| 3150-0002  | SPACER-PUSHBUTTON SW, DOGBONE     | 4.0 |
| 01700-5004 | PC BOARD-ANALYZER FREQUENCY       | 1.0 |

# 01700-30011 ASSY-PC, ANAL FREQ 3RD DIGIT

| PART NO   | DESCRIPTION                    | QTY |
|-----------|--------------------------------|-----|
| 1015-3178 | RES-FXD 178K 1% 1/8W MF<br>R72 | 1.0 |
| 1015-3200 | RES-FXD 200K 1% 1/8W MF<br>R71 | 1.0 |
| 1015-3226 | RES-FXD 226K 1% 1/8W MF<br>R70 | 1.0 |
| 1015-3267 | RES-FXD 267K 1% 1/8W MF<br>R69 | 1.0 |
| 1015-3324 | RES-FXD 324K 1% 1/8W MF<br>R68 | 1.0 |
| 1015-3887 | RES-FXD 887K 1% 1/8W MF<br>R63 | 1.0 |
| 1015-4100 | RES-FXD 1M 1% 1/8W MF<br>R62   | 1.0 |
| 1100-3390 | RES-FXD 390K 5% 1/4W<br>R67    | 1.0 |
| 1100-3560 | RES-FXD 560K 5% 1/4W<br>R66    | 1.0 |
| 1100-3820 | RES-FXD 820K 5% 1/4W<br>R65    | 1.0 |
| 1100-4110 | RES-FXD 1.1M 5% 1/4W<br>R61    | 1.0 |
| 1100-4130 | RES-FXD 1.3M 5% 1/4W<br>R60    | 1.0 |
| 1100-4160 | RES-FXD 1.6M 5% 1/4W<br>R59,64 | 2.0 |



| PART NO    | DESCRIPTION                   |
|------------|-------------------------------|
| 1100-4200  | RES-FXD 2M 5% 1/4W<br>R58     |
| 1100-4270  | RES-FXD 2.7M 5% 1/5W<br>R57   |
| 1100-4390  | RES-FXD 3.9M 5% 1/4W<br>R56   |
| 1100-4820  | RES-FXD 8.2M 5% 1/4W<br>R55   |
| 3015-0004  | SWITCH-PB, 10 STR-6P<br>S11   |
| 3150-0002  | SPACER-PUSHBUTTON SW, DOGBONE |
| 01700-5004 | PC BOARD-ANALYZER FREQUENCY   |

#### 01700-30012 ASSY-PC, OSC FREQ 2ND DIGIT

| PART NO    | DESCRIPTION                             |
|------------|-----------------------------------------|
| 1005-2174  | RES-FXD 17.4K 0.25% 1/8W MF<br>R127,136 |
| 1005-2196  | RES-FXD 19.6K 0.25% 1/8W MF<br>R126,135 |
| 1005-2226  | RES-FXD 22.6K 0.25% 1/8W MF<br>R125,134 |
| 1015-2261  | RES-FXD 26.1K 1% 1/8W MF<br>R124,133    |
| 1015-2316  | RES-FXD 31.6K 1% 1/8W MF<br>R123,132    |
| 1015-2392  | RES-FXD 39.2K 1% 1/8W MF<br>R122,131    |
| 1015-2523  | RES-FXD 52.3K 1% 1/8W MF<br>R121,130    |
| 1015-2787  | RES-FXD 78.7K 1% 1/8W MF<br>R120,129    |
| 1015-3158  | RES-FXD 158K 1% 1/8W MF<br>R119,128     |
| 3015-0003  | SWITCH-PB, 10 STR-4P<br>S13             |
| 3150-0002  | SPACER-PUSHBUTTON SW, DOGBONE           |
| 01700-5002 | PC BOARD-OSC FREQUENCY                  |

#### 01700-30013 ASSY-PC, OSC FREQ 3RD DIGIT

| PART NO    | DESCRIPTION                         |
|------------|-------------------------------------|
| 1015-3178  | RES-FXD 178K 1% 1/8W MF<br>R145,154 |
| 1015-3200  | RES-FXD 200K 1% 1/8W MF<br>R144,153 |
| 1015-3226  | RES-FXD 226K 1% 1/8W MF<br>R143,152 |
| 1015-3267  | RES-FXD 267K 1% 1/8W MF<br>R142,151 |
| 1015-3324  | RES-FXD 324K 1% 1/8W MF<br>R141,150 |
| 1100-3390  | RES-FXD 390K 5% 1/4W<br>R140,149    |
| 1100-3560  | RES-FXD 560K 5% 1/4W<br>R139,148    |
| 1100-3820  | RES-FXD 820K 5% 1/4W<br>R138,147    |
| 1100-4160  | RES-FXD 1.6M 5% 1/4W<br>R137,146    |
| 3015-0003  | SWITCH-PB, 10 STR-4P<br>S14         |
| 3150-0002  | SPACER-PUSHBUTTON SW, DOGBONE       |
| 01700-5002 | PC BOARD-OSC FREQUENCY              |

#### 01700-30014 INPUT SWITCH ASSEMBLY 1700A

| PART NO   | DESCRIPTION                                 | QTY |
|-----------|---------------------------------------------|-----|
| 1000-0001 | RES-FXD 102 0.1% 1/8W<br>R144               | 1.0 |
| 1000-0002 | RES-FXD 953 0.1% 1/8W<br>R118               | 1.0 |
| 1000-0003 | RES-FXD 3.92K 0.1% 1/8W<br>R120             | 1.0 |
| 1005-0221 | RES-FXD 221 0.25% 1/8W MF<br>R143           | 1.0 |
| 1005-0698 | RES-FXD 698 0.25% 1/8W MF<br>R142           | 1.0 |
| 1005-1102 | RES-FXD 1.02K 0.25% 1/8W MF<br>R105,110     | 2.0 |
| 1005-1221 | RES-FXD 2.21K 0.25% 1/8W MF<br>R104,109,141 | 3.0 |
| 1005-1698 | RES-FXD 6.98K 0.25% 1/8W MF<br>R103,108,142 | 3.0 |
| 1007-2221 | RES-FXD 22.1K 0.25% 1/2W MF<br>R102,107     | 2.0 |
| 1008-2698 | RES-FXD 69.8K 0.25% 1W MF<br>R101,106       | 2.0 |
| 1100-2560 | RES-FXD 56K 5% 1/4W<br>R117                 | 1.0 |
| 1100-3910 | RES-FXD 910K 5% 1/4W<br>R119                | 1.0 |
| 2000-0005 | CAP-FXD 5PF 10% 500V MICA<br>C116,118       | 2.0 |
| 3010-0001 | SWITCH-ROTARY, INPUT 1700A<br>S1            | 1.0 |

#### 01700-30015 RATIO SWITCH ASSEMBLY 1700A

| PART NO   | DESCRIPTION                             | QTY |
|-----------|-----------------------------------------|-----|
| 1005-0475 | RES-FXD 475 0.25% 1/8W MF<br>R232       | 1.0 |
| 1005-0690 | RES-FXD 690 0.25% 1/8W MF<br>R226-231   | 6.0 |
| 1005-1102 | RES-FXD 1.02K 0.25% 1/8W MF<br>R219-225 | 7.0 |
| 1015-2681 | RES-FXD 68.1K 1% 1/8W MF<br>R233        | 1.0 |
| 1100-0360 | RES-FXD 360 5% 1/4W<br>R218             | 1.0 |
| 2100-0001 | CAP-FXD 1UF 25V ELECT AL<br>C312,323    | 2.0 |
| 2100-0003 | CAP-FXD 10UF 25V ELECT AL<br>C313,324   | 2.0 |
| 2100-0006 | CAP-FXD 100UF 25V ELECT AL<br>C314,315  | 2.0 |
| 2100-0017 | CAP-FXD 33UF 15V ELECT LO LEAK<br>C325  | 1.0 |
| 2100-0018 | CAP-FXD 100UF 25V ELEC LO LEAK<br>C326  | 1.0 |
| 3010-0000 | SWITCH-ROTARY, RATIO 1700A<br>S2        | 1.0 |

